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(54) **GROUTING STRUCTURE FILLED WITH SOLUBLE CRYSTAL AND CONSTRUCTION METHOD**

MIT LÖSLICHEM KRISTALL GEFÜLLTE VERGUSSSTRUKTUR UND HERSTELLUNGSVERFAHREN

STRUCTURE D'INJECTION REMPLIE D'UN CRISTAL SOLUBLE ET PROCÉDÉ DE CONSTRUCTION

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Description

Technical Field

[0001] The present invention relates to the technical field of slope drainage engineering, and in particular, to a grouting structure filled with soluble crystals and a construction method thereof.

Background

[0002] Rainfall infiltration is one of the important factors to change the mechanical parameters of the slope and induce landslides. Timely and effective drainage of the slope is an effective way to solve this problem. The existing drainage measures for slope mainly include surface drainage ditch, blind ditch, collecting well, horizontal drainage borehole, underground drainage hole, negative pressure drainage, etc.

[0003] The existing negative pressure drainage technology for slope mainly divides the slope boreholes into a water-permeable borehole section and a grouting seal borehole section, with a water-stop ring made of water-expanding rubber in between. As described in the Chinese Patent, publication No. CN107246019A, side slope underground water drilling self-starting negative pressure drainage system and method, wherein a declination borehole grout into the grouting seal borehole section, and the reserved water-permeable borehole section is isolated from the outside atmosphere. The water inlet of the drain pipe is arranged in the permeable pipe, and the water outlet of such pipe extends out of the ground through the water-stop ring made of water-expanding rubber for drainage. Before the drainage process occurs, the pressure in the borehole will gradually increase with the infiltration of groundwater, leading to the natural outflow of the groundwater from the water outlet. When the drainage process takes place, because the drainage capacity of the drain pipe is greater than the flow rate of groundwater in the slope infiltrating into the cavity of the water-permeable borehole section and the air pressure in the permeable pipe is lower than the atmospheric pressure (a negative pressure is formed), the water in the soil around the permeable pipe continues to flow towards it, forcing the groundwater in the slope to flow rapidly towards the borehole to drain to the surface. At the same time, due to the negative pressure in the permeable pipe, the water in all directions around the permeable pipe will flow towards it, so the drainage range will increase, and such increased drainage range is more conducive to discharging the groundwater in the slope.

[0004] However, in the process of on-site construction, the difficulty of negative pressure drainage technology is that the water-permeable borehole section needs to maintain its permeability, and the slurry of the grouting seal borehole section cannot enter the water-permeable borehole section. If the pressure of grouting is high, the slurry will often break through the baffle structure such

as the water-stop ring made of water-expanding rubber and enter the water-permeable borehole section, resulting in the failure of the borehole; if the pressure of grouting is small, the borehole section cannot be closed and the negative pressure cannot be formed. Accordingly, in order to solve the above problems, a new grouting technology is required. WO2019/000776 discloses a grouting structure, comprising: a water-permeable section (water-permeable drilling section 6) and a grouting section (grouting closed drilling section 7), wherein the water-permeable section (6) is located at the lower part of a declination borehole (1 and the grouting section (7) is situated at the upper part of the borehole (1); a water-stop component (water-expanding rubber water stop ring 3) is arranged between the water-permeable section (7) and the grouting section (7); a permeable pipe (water pipe 4) is arranged in the water-permeable section (6); the top of the permeable pipe (4) is in contact with the water-stop component (3); a cavity is formed in the permeable pipe (4); the groundwater penetrates into the cavity through the permeable pipe (4); the water inlet of the drain pipe (4) is arranged in the water-permeable section (6), and the water inlet of the a drain pipe (drain pipe 8) is inserted into the permeable pipe (4) after passing through the water-stop component (3); the water outlet of the drain pipe (8) is located at the lower part of the slope (1 0); the elevation of the water inlet of the drain pipe (8) is higher than that of the water outlet of the drain pipe (8), and the lift of the drain pipe (8) is less than the height of the water column (11) corresponding to the atmospheric pressure; the space between the drain pipe (8) and the wall of the borehole of the grouting section (7) is used for grouting. However it does not disclose that the pipe is filled with solid soluble crystals.

Summary

[0005] For overcoming the deficiency of existing negative pressure drainage technology in controlling the pressure of grouting and the consequent failure in negative pressure drainage, an object of the present invention is to provide a grouting structure filled with soluble crystals and a construction method thereof.

[0006] Accordingly, in order to accomplish the above objects, the present invention provides the following technologies:

A grouting structure filled with soluble crystals, comprising a water-permeable section and a grouting section, wherein the water-permeable section is located at the lower part of a declination borehole, and the grouting section is situated at the upper part of the borehole; a water-stop component is arranged between the water-permeable section and the grouting section; a permeable pipe is arranged in the water-permeable section; the top of the permeable pipe is in contact with the water-stop component; a cavity is formed in the permeable pipe; the groundwater penetrates into the cavity through the permeable pipe; a water inlet of the drain pipe is arranged

in the water-permeable section, and the water inlet of the drain pipe is inserted into the permeable pipe after passing through the water-stop component; a water outlet of the drain pipe is located at the lower part of the slope; an elevation of the water inlet of the drain pipe is higher than that of the water outlet of the drain pipe, and the lift of the drain pipe is less than the height of the water column corresponding to the atmospheric pressure; a space between the drain pipe and the wall of the borehole of the grouting section is grouted; wherein the permeable pipe is filled with solid soluble crystals.

[0007] The permeable pipe is a pipe with permeable holes on its pipe wall.

[0008] The lift of the drain pipe being smaller than the height of the water column corresponding to atmospheric pressure means the height difference between the water inlet of the drain pipe and the borehole orifice is smaller than the height of the water column corresponding to the local atmospheric pressure in order to perform negative pressure drainage.

[0009] The present invention provides a grouting structure filled with soluble crystals, wherein the permeable pipe is filled with the solid soluble crystals to support the water-stop component to a certain extent during grouting, contributing to the prevention of the slurry from entering the water-permeable section, and the water-stop component from being squeezed to cause a large displacement; at the same time, grouting pressure will be increased to reduce the porosity of the grouting section and a better sealing can be achieved to ensure the negative pressure effect of the water-permeable section. The soluble crystals can dissolve, thereby changing the osmotic pressure of the surrounding soil, leading to the water flow from the surrounding soil to the permeable section and finally forcing the groundwater in the slope to be discharged to the surface; the cavity in the permeable pipe can facilitate the infiltration of groundwater after the soluble crystals dissolve. The present structure is beneficial to increase the pressure of grouting, reduce cracks in the grouting section, and improve the sealing effect, thus enhancing the negative pressure effect of the water-permeable section, effectively supporting the water-stop component during grouting, preventing the slurry from entering the water-permeable section and the consequent interference in the formation of a negative pressure environment, avoiding blockage of the permeable pipe, and preventing large displacement of the water-stop component by squeezing. It is conducive to ensuring continuous drainage of the deep portion of the slope, and is of great significance in solving the problem of drainage treatment of large-scale landslide.

[0010] Preferably, the soluble crystals comprise at least one of solid salt, solid sugar, solid alum and solid ice.

[0011] Different soluble crystals have different dissolution rates, and can be selected and matched according to actual needs. Among them, solid salt and solid alum, after dissolving, will form a certain residue in the water-permeable section and the drain pipe, contributing to the

inhibition of growth of plants in the drain pipe and the water-permeable section, the effective avoidance of blockage, and the guarantee of effectiveness and continuity of the entire drainage system.

5 **[0012]** Preferably, the slurry of the grouting section is cement mortar or cement-sodium silicate slurry.

[0013] Preferably, the water-stop component includes a water-stop strip made of water-expanding rubber, a water-stop belt or sandbags.

10 **[0014]** Preferably, the bottom of the permeable pipe is provided with a pipe boot.

[0015] It is conducive to avoiding blockage at the bottom of the permeable pipe due to accumulation of sand and gravel and the consequent impact on drainage.

15 **[0016]** A construction method for a grouting structure filled with soluble crystals, using any of the above-mentioned grouting structures filled with soluble crystals, comprising the following steps:

- 20 a. drilling a declination borehole according to the geological survey, and making the water-permeable section of the borehole below the groundwater level line of the slope;
- b. arranging a permeable pipe in the water-permeable section, and then inserting a drain pipe into the permeable pipe;
- 25 c. filling the permeable pipe with solid soluble crystals, and then installing a water-stop component to block the water-permeable section;
- 30 d. injecting slurry into the borehole to form a grouting section, and the completing the construction of the grouting structure.

35 **[0017]** Adopting a construction method of a grouting structure filled with soluble crystals recites in the present invention, wherein the permeable pipe is filled with solid soluble crystals to support the water-stop component, does not increase additional difficulty and cost, effectively improving the pressure of grouting in the grouting process, contributing to the improvement of grouting efficiency and avoidance of the damage to the water-stop component, and effectively ensuring the grouting effect, thereby guaranteeing the effective formation of a negative pressure environment for efficient operation of the drainage system and continuous drainage.

40 **[0018]** Preferably, after step d, the following steps are also included:

- e. injecting water into the permeable pipe from the water outlet of the drain pipe;
- f. drawing the solution out from the water outlet of the drain pipe and testing it after the soluble crystals are dissolved;
- 45 g. stopping suction and completing the construction of the grouting structure when the concentration ρ of the soluble crystals in the solution meets the requirements.

[0019] It is beneficial to dissolve the soluble crystals at a rapid pace so as to perform drainage as soon as possible.

[0020] Preferably, in the step g., stop suction when the concentration ρ of the soluble crystals is less than or equal to $1/2 \rho_0$, wherein ρ_0 stands for the initial concentration of the soluble crystals.

[0021] Preferably, in the step e, inject water above 40° C.

[0022] To sum up, compared with the existing art, the beneficial effects of the present invention are:

1. The present structure is beneficial to increase the pressure of grouting, reduce cracks in the grouting section, and improve the sealing effect, thus enhancing the negative pressure effect of the water-permeable section, effectively supporting the water-stop component during grouting, preventing the slurry from entering the water-permeable section and the consequent interference in the formation of a negative pressure environment, avoiding blockage of the permeable pipe, and preventing large displacement of the water-stop component by squeezing. It is conducive to ensuring continuous drainage of the deep portion of the slope, and is of great significance in solving the problem of drainage treatment of large-scale landslide.

2. Adopting a construction method of a grouting structure filled with soluble crystals recites in the present invention, wherein the permeable pipe is filled with solid soluble crystals to support the water-stop component, does not increase additional difficulty and cost, effectively improving the pressure of grouting in the grouting process, contributing to the improvement of grouting efficiency and avoidance of the damage to the water-stop component, and effectively ensuring the grouting effect, thereby guaranteeing the effective formation of a negative pressure environment for efficient operation of the drainage system and continuous drainage.

Brief Description of Drawings

[0023]

FIG. 1 is a structure view of a grouting structure filled with soluble crystals of the present invention;

FIG. 2 is a view of drainage of a grouting structure filled with soluble crystals of the present invention.

[0024] Element Reference: 1-permeable pipe, 21-water-permeable section, 22-grouting section, 23-water-stop component, 24-slurry, 3-soluble crystals, 4-drain pipe, 5-groundwater level line.

Description of Embodiments

[0025] The present invention will be further described

in detail below with reference to the accompanying drawings and specific embodiments. However, it shall not be construed that the scope of the above-mentioned subject matter of the present invention is limited to the following embodiments, as all technologies realized based on the content of the present invention belong to the scope of the present invention.

Embodiment 1

[0026] Referring to FIG. 1, a grouting structure filled with soluble crystals of the present invention, comprising a water-permeable section 21 and a grouting section 22, wherein the water-permeable section 21 is located at the lower part of a declination borehole, and the grouting section 22 is situated at the upper part of the borehole; a water-stop component 23 is arranged between the water-permeable section 21 and the grouting section 22; a permeable pipe 1 is arranged in the water-permeable section 21; the top of the permeable pipe 1 contacts the water-stop component 23; a cavity is formed in the permeable pipe 1; the permeable pipe 1 is filled with solid soluble crystals 3; the groundwater penetrates into the cavity through the permeable pipe 1; the water inlet of the drain pipe 4 is arranged in the water-permeable section 21, and the water inlet of the drain pipe 4 inserts into the permeable pipe 1 after passing through the water-stop component 23; the water outlet of the drain pipe 4 is located at the lower part of the slope; the elevation of the water inlet of the drain pipe 4 is higher than that of the water outlet of the drain pipe 4, the lift of the drain pipe 4 is less than the height of the water column corresponding to the atmospheric pressure; the space between the drain pipe 4 and the wall of the borehole of the grouting section 22 is used for grouting.

[0027] Specifically, the diameter of the borehole should be larger than 90mm, and the permeable pipe 1 can be a corrugated pipe, externally covered with filter cloth and internally supported by HDPE, preventing large particles such as coarse sand and gravel from entering; a pipe boot is set at the bottom of the permeable pipe 1; the pipe boot can be a HDPE pipe with a sealed bottom and an open top, and is sleeved on the bottom of the permeable pipe 1 (not shown in the FIG); the drain pipe 4 can be a PA pipe with a diameter of 4-8mm; the drain pipe 4 has good air tightness; the drainage capacity of the drain pipe 4 is greater than the flow rate of groundwater in slope infiltrating into the water-permeable section 21, facilitating natural drainage when the water head height of the cavity in the permeable pipe 1 is greater than the orifice elevation of the borehole as a result of elevated groundwater level, discharging groundwater of the slope in real time, and keeping the groundwater below the safe water level; the slurry 24 of the grouting section 22 is cement mortar or cement-sodium silicate slurry, cutting off the water-gas connection between the ground surface and the cavity of the water-permeable borehole section; the water-stop component 23 includes a water-

stop ring made of water-expanding rubber, a water-stop belt or sandbags; after the water-stop component 23 is closed, the gap between the drain pipe 4 and the wall of the borehole of the grouting section 22 is closed by grouting.

[0028] The soluble crystals 3 comprise at least one of solid salt, solid sugar, solid alum and solid ice. The space between the permeable pipe 1 and the drain pipe 4 is filled with the soluble crystals 3, providing effective support for the water-stop component 23 during grouting. After that, groundwater will flow into or additional water will be added into the permeable pipe 1 over time, dissolving the soluble crystals 3 and then freeing the cavity in the permeable pipe 1 for drainage. Different soluble crystals 3 have different dissolution rates and can be selected according to actual needs. The present structure is beneficial to increase the pressure of grouting, reduce cracks in the grouting section, and improve the sealing effect, thus enhancing the negative pressure effect of the water-permeable section, effectively supporting the water-stop component during grouting, preventing the slurry from entering the water-permeable section and the consequent interference in the formation of a negative pressure environment, avoiding blockage of the permeable pipe, and preventing large displacement of the water-stop component by squeezing; besides, solid salt and solid alum, after dissolving, will form a certain residue in the water-permeable section 21 and the drain pipe 4, contributing to the inhibition of growth of plants in the drain pipe 4 and the water-permeable section 21, the effective avoidance of blockage, and the guarantee of availability and continuity of the entire drainage system. solid salt and solid alum, after dissolving, will form a certain residue in the water-permeable section 21 and the drain pipe 4, contributing to the inhibition of growth of plants in the drain pipe 4 and the water-permeable section 21, the effective avoidance of blockage, and the guarantee of effectiveness and continuity of the entire drainage system.

Embodiment 2

[0029] The construction method of a grouting structure filled with soluble crystals according to the present invention adopts a grouting structure filled with soluble crystals as described in Embodiment 1, and includes the following steps:

a. drilling a declination borehole according to the geological survey, and making the water-permeable section 21 of the borehole below the groundwater level line 5 of the slope, that is, the position of the water-permeable section 21 is set according to the water level of the groundwater level line 5; the height difference between the bottom of the borehole and the orifice of the borehole is less than the height of the water column corresponding to the local atmospheric pressure, ensuring that the lift of the drain pipe

4 meets the requirements;

b. arranging a permeable pipe 1 in the water-permeable section 21, and then inserting a drain pipe 4 into the permeable pipe 1 with the port of the drain pipe 4 extending into the bottom of the permeable pipe 1;

c. filling the permeable pipe 1 with solid soluble crystals 3 until it is full, and then installing a water-stop component 23 to block the water-permeable section 21;

d. injecting slurry 24 into the borehole to form the grouting section 22 by the backward method can increase the pressure of grouting during grouting; the slurry 24 flowing into the surrounding soil to further ensure the sealing of the grouting section 22.

e. injecting water, such as water above 40° C, into the permeable pipe 1 from the water outlet of the drain pipe 4;

f. drawing the solution out from the water outlet of the drain pipe 4 and testing it after the soluble crystals 3 are dissolved; stopping suction and completing the construction of the grouting structure when the concentration ρ of the soluble crystals 3 in the solution meets the requirements.

[0030] In step 1, the solubility of the soluble crystals 3 can be roughly obtained according to the amount of water injected and the amount of the soluble crystals 3. The prediction of reaching the predetermined solubility according to time is acceptable, and complete dissolution is not a must. The cavity in the permeable pipe 1 can be vacated more quickly with water injection, as such, the groundwater in the surrounding soil can penetrate into the permeable pipe 1.

[0031] In step 1, the pumping is stopped when it is detected that the concentration ρ of the soluble crystals 3 is less than or equal to $1/2 \rho_0$, wherein ρ_0 is the initial concentration of the soluble crystals 3 and can be roughly obtained according to the volume of the water-permeable section, the amount of water injected and the mass of the soluble crystals 3, or by referring to the concentration of the liquid extracted for the first time after a certain period of time. The aforementioned concentration requirements are mainly used to roughly grasp the dissolution of the soluble crystals 3.

[0032] Water injection is optional, that is, not to perform steps e and 1, but to utilize the penetration of groundwater into the permeable section 21 to dissolve the soluble crystals 3. During the dissolution process, the osmotic pressure increases, the attraction to groundwater elevates, and then the infiltration of groundwater into the permeable pipe 1 is accelerated; at the same time, the solution will diffuse freely and the groundwater can still effectively dissolve the soluble crystals 3 when the groundwater needs to be drained.

[0033] When the soluble crystal 3 is solid ice it can be effectively melt since the soil has a temperature and there is no need to inject water; after the ice melts, the cavity in the permeable pipe 1 is vacated and there is no need

to test the concentration.

[0034] As shown in FIG. 2, after the construction is completed, since the groundwater level line 5 in the slope is higher than the highest point of the drain pipe 4 (that is where the orifice of the borehole is located), the water head height of the water inlet of the drain pipe 4 is higher than that of the orifice of the borehole, discharging groundwater in the water-permeable section 21 by the drain pipe 4 under a water head difference, and triggering a drainage process. When the groundwater level drops below the highest point of the drain pipe 4, a siphon drainage process is started and negative pressure is generated in the water-permeable section 21. As such, the groundwater in the slope accelerates into the cavity, and after the groundwater in the cavity and the soil above the water-permeable section 21 in the slope is drained, an entire drainage process ends; wherein with cycles of rain-fall infiltration, the drainage process circulates, effectively realizing continuous drainage of a deep portion of the slope, solving a problem of drainage treatment of large landslide, and ensuring the stability of the slope with low maintenance cost.

Claims

1. A grouting structure filled with soluble crystals, comprising: a drain pipe (4), a water-permeable section (21) and a grouting section (22), wherein the water-permeable section (21) is located at the lower part of a declination borehole, and the grouting section (22) is situated at the upper part of the borehole; a water-stop component (23) is arranged between the water-permeable section (21) and the grouting section (22); a permeable pipe (1) is arranged in the water-permeable section (21); the top of the permeable pipe (1) is in contact with the water-stop component (23); a cavity is formed in the permeable pipe (1); the groundwater penetrates into the cavity through the permeable pipe (1); a water inlet of the drain pipe (4) is arranged in the water-permeable section (21), and the water inlet of the drain pipe (4) is inserted into the permeable pipe (1) after passing through the water-stop component (23); a water outlet of the drain pipe (4) is located at the lower part of the slope; an elevation of the water inlet of the drain pipe (4) is higher than that of the water outlet of the drain pipe (4), and the lift of the drain pipe (4) is less than the height of the water column corresponding to the atmospheric pressure; a space between the drain pipe (4) and the wall of the borehole of the grouting section (22) is grouted; wherein the permeable pipe (1) is filled with solid soluble crystals (3);
2. The grouting structure, as recited in claim 1, wherein the soluble crystals (3) comprise at least one of solid salt, solid sugar, solid alum and solid ice.

3. The grouting structure, as recited in claim 1, wherein a slurry (24) of the grouting section (22) is cement mortar or cement-sodium silicate slurry.
4. The grouting structure, as recited in any one of claims 1-3, wherein the water-stop component (23) includes a water-stop strip made of water-expanding rubber, a water-stop belt or sandbags.
5. The grouting structure, as recited in any one of claims 1-3, wherein the bottom of the permeable pipe (1) is provided with a pipe boot.
6. A construction method for a grouting structure filled with soluble crystals, wherein any grouting structure filled with soluble crystals is applied in accordance with claims 1-5, comprises the following steps:
 - a. drilling a declination borehole according to the geological survey, and making the water-permeable section (21) of the borehole below the groundwater level line (5) of the slope;
 - b. arranging a permeable pipe (1) in the water-permeable section (21), and then inserting a drain pipe (4) into the permeable pipe (1);
 - c. filling the permeable pipe (1) with solid soluble crystals (3), and then installing a water-stop component (23) to block the water-permeable section (21);
 - d. injecting slurry (24) into the borehole to form a grouting section (22), and then completing the construction of the grouting structure.
7. The construction method, as recited in claim 6, wherein the following steps are included after step d:
 - e. injecting water into the permeable pipe (1) from the water outlet of the drain pipe (4);
 - f. drawing the solution out from the water outlet of the drain pipe (4) and testing it after the soluble crystals (3) are dissolved;
 - g. stopping suction and completing the construction of the grouting structure when the concentration ρ of the soluble crystals (3) in the solution meets the requirements.
8. The construction method, as recited in claim 7, wherein suction is stopped when the concentration ρ of the soluble crystals (3) is less than or equal to $1/2 \rho_0$ in the step 1, wherein ρ_0 stands for the initial concentration of the soluble crystals.
9. The construction method, as recited in claim 7, wherein water above 40°C is injected in the step e.

Patentansprüche

1. Eine mit löslichen Kristallen gefüllte Verpressstruktur, umfassend: ein Abflussrohr (4),

einen wasserdurchlässigen Abschnitt (21) und einen Verpressabschnitt (22), wobei der wasserdurchlässige Abschnitt (21) am unteren Teil eines Deklinationsbohrlochs angeordnet ist und der Verpressabschnitt (22) am oberen Teil des Bohrlochs angeordnet ist; wobei ein Wasserstoppbauteil (23) zwischen dem wasserdurchlässigen Abschnitt (21) und dem Verpressabschnitt (22) angeordnet ist; wobei ein durchlässiges Rohr (1) in dem wasserdurchlässigen Abschnitt (21) angeordnet ist; wobei der obere Teil des durchlässigen Rohrs (1) mit dem Wasserstoppbauteil (23) in Kontakt ist; wobei im durchlässigen Rohr (1) ein Hohlraum gebildet wird; wobei durch das durchlässige Rohr (1) das Grundwasser in den Hohlraum eindringt; wobei in dem wasserdurchlässigen Abschnitt (21) ein Wasserzulauf des Abflussrohrs (4) angeordnet ist und der Wasserzulauf des Abflussrohrs (4) nach dem Passieren des Wasserstoppbauteils (23) in das durchlässige Rohr (1) eingeführt wird; wobei sich der Wasserablauf des Abflussrohrs (4) am unteren Teil der Böschung befindet; wobei eine Höhe des Wassereinlasses des Abflussrohrs (4) höher ist als die des Wasserauslasses des Abflussrohrs (4) und die Höhe des Abflussrohrs (4) geringer ist als die Höhe der Wassersäule, welche dem atmosphärischen Druck entspricht; wobei ein Freiraum zwischen dem Abflussrohr (4) und der Bohrlochwand des Verpressabschnitts (22) eingegossen wird; wobei das durchlässige Rohr (1) mit festen löslichen Kristallen (3) gefüllt ist;

2. Die Vergussstruktur nach Anspruch 1, wobei die löslichen Kristalle (3) mindestens eines der folgenden Bestandteile umfassen: Feststoffsalt, Feststoffzucker, Feststoffalaun und Feststoffeis.

3. Verpressstruktur nach Anspruch 1, wobei die Aufschlammung (24) des Verpressabschnitts (22) Zementmörtel oder Zement-Natriumsilikat-Aufschlammung ist.

4. Die Verpressstruktur nach einem der Ansprüche 1 bis 3, wobei die Wasserstoppbauteile (23) einen Wasserstopfstreifen aus wasserausdehnendem Gummi, ein Wasserstopband oder Sandsäcke umfasst.

5. Die Verpressstruktur nach einem der Ansprüche 1 bis 3, wobei der Boden des durchlässigen Rohrs (1) mit einer Rohrmanschette versehen ist.

6. Ein Konstruktionsverfahren für eine mit löslichen Kristallen gefüllte Verpressstruktur, wobei jede mit löslichen Kristallen gefüllte Verpressstruktur gemäß den Ansprüchen 1 bis 5 angewendet wird, umfasst die folgenden Schritte:

- Bohrung eines Deklinationsbohrlochs entsprechend der geologischen Vermessung und Herstellung des wasserdurchlässigen Abschnitts (21) des Bohrlochs unterhalb der Grundwasserstandslinie (5) des Hanges;
- Anordnung eines durchlässigen Rohrs (1) in dem wasserdurchlässigen Abschnitt (21) und anschließendes Einsetzen eines Ablaufrohrs (4) in das durchlässige Rohr (1);
- Füllung des durchlässigen Rohrs (1) mit festen, löslichen Kristallen (3) und anschließende Installation eines Wasserstoppbauteils (23) zur Blockierung des wasserdurchlässigen Abschnitts (21);
- Injizierung von Aufschlammung (24) in das Bohrloch, um einen Verpressabschnitt (22) zu bilden, und anschließende Fertigstellung der Verpressstruktur.

7. Das Konstruktionsverfahren nach Anspruch 6, wobei die folgenden Schritte nach dem Schritt d enthalten sind:

- Injizierung von Wasser in das durchlässige Rohr (1) aus dem Wasserauslass des Abflussrohrs (4);
- Entnahme der Lösung aus dem Wasserausgang des Abflussrohrs (4) und Prüfung nach Auflösung der löslichen Kristalle (3);
- Beendigung der Absaugung und Fertigstellung der Injektionsstruktur, wenn die Konzentration ρ der löslichen Kristalle (3) in der Lösung den Anforderungen entspricht.

8. Das Konstruktionsverfahren nach Anspruch 7, wobei die Absaugung gestoppt wird, wenn die Konzentration ρ der löslichen Kristalle (3) im Schritt f kleiner als oder gleich $1/2 \rho_0$ ist, wobei ρ_0 für die Anfangskonzentration der löslichen Kristalle steht.

9. Das Konstruktionsverfahren nach Anspruch 7, wobei im Schritt e Wasser mit einer Temperatur von über 40°C injiziert wird.

Revendications

1. Structure d'injection remplie de cristaux solubles, comprenant : un drain (4), une section perméable (21) et une section d'injection (22), **caractérisée en ce que** la section perméable (21) étant située dans la partie inférieure d'un trou de forage oblique ; et la

section d'injection (22) étant située dans la partie supérieure du trou de forage ; un composant d'arrêt d'eau (23) étant disposé entre la section perméable (21) et la section d'injection (22) ; un tuyau perméable (1) étant disposé dans la section perméable (21) ; la partie supérieure du tuyau perméable (1) étant mise en contact avec le composant d'arrêt d'eau (23) ; une cavité étant formée dans le tuyau perméable (1) ; l'eau souterraine pénétrant dans la cavité à travers le tuyau perméable (1) ; une entrée d'eau du drain (4) étant disposée dans la section perméable (21) ; et l'entrée d'eau du drain (4) étant insérée dans le tuyau perméable (1) après le franchissement du composant d'arrêt d'eau (23) ; une sortie d'eau du drain (4) étant située dans la partie inférieure de la pente ; la hauteur de l'entrée d'eau du drain (4) étant supérieure à celle de la sortie d'eau du drain (4) ; et la hauteur du drain (4) étant inférieure à la hauteur de la colonne d'eau correspondant à la pression atmosphérique ; un espace entre le drain (4) et la paroi du trou de forage de la section d'injection (22) étant injecté ;

caractérisée en ce que le tuyau perméable (1) étant rempli de cristaux solides solubles (3).

2. Structure d'injection selon la revendication 1, **caractérisée en ce que** les cristaux solubles (3) comprennent au moins l'un des éléments suivants : sel solide, sucre solide, alun solide et glace solide.

3. Structure d'injection selon la revendication 1, **caractérisée en ce que** la solution de mortier (24) de la section d'injection (22) est un mortier de ciment ou une solution de ciment-silicate de sodium.

4. Structure d'injection selon l'une des revendications 1 à 3, **caractérisée en ce que** le composant d'arrêt d'eau (23) comprend une bande d'arrêt d'eau en caoutchouc d'expansion, une ceinture d'arrêt d'eau ou des sacs de sable.

5. Structure d'injection selon l'une des revendications 1 à 3, **caractérisée en ce que** le fond du tuyau perméable (1) est pourvu d'un sabot de tuyau.

6. Procédé de construction d'une structure d'injection remplie de cristaux solubles, **caractérisé en ce que** toute structure d'injection remplie de cristaux solubles étant appliquée selon l'une des revendications 1 à 5, comprenant les étapes suivantes :

a. forer un trou de forage oblique selon l'étude géologique, et réaliser la section perméable (21) du trou de forage sous la ligne de niveau de la nappe phréatique (5) de la pente ;

b. disposer un tuyau perméable (1) dans la section perméable (21), et puis insérer un drain (4) dans le tuyau perméable (1) ;

c. remplir le tuyau perméable (1) de cristaux solides solubles (3), et puis monter un composant d'arrêt d'eau (23) pour obturer la section perméable (21) ;

d. injecter la solution (24) dans le trou de forage pour former une section d'injection (22), et puis achever la construction de la structure d'injection.

7. Procédé de construction selon la revendication 6, **caractérisé en ce que** les étapes suivantes sont incluses après la réalisation de l'étape d :

e. injection d'eau dans le tuyau perméable (1) à partir de la sortie d'eau du drain (4) ;

f. aspirer la solution à partir de la sortie d'eau du drain (4) et la tester après dissolution des cristaux solubles (3) ;

g. arrêter l'aspiration et achever la construction de la structure d'injection lorsque la concentration ρ des cristaux solubles (3) dans la solution répond aux exigences.

8. Procédé de construction selon la revendication 7, **caractérisé en ce que** l'aspiration est arrêtée lorsque la concentration ρ des cristaux solubles (3) est inférieure ou égale à $1/2 \rho_0$ dans l'étape f, où ρ_0 représente la concentration initiale des cristaux solubles.

9. Procédé de construction selon la revendication 7, **caractérisé en ce que** l'eau avec température plus de 40°C est injectée dans l'étape e.

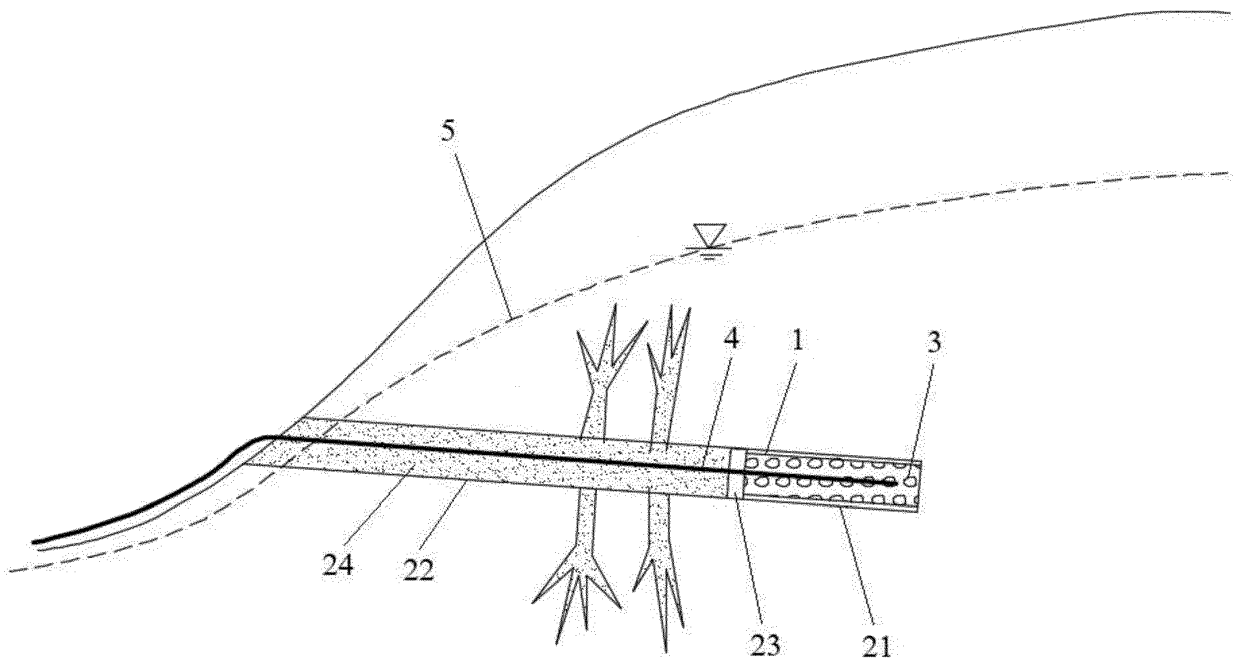


Fig 1

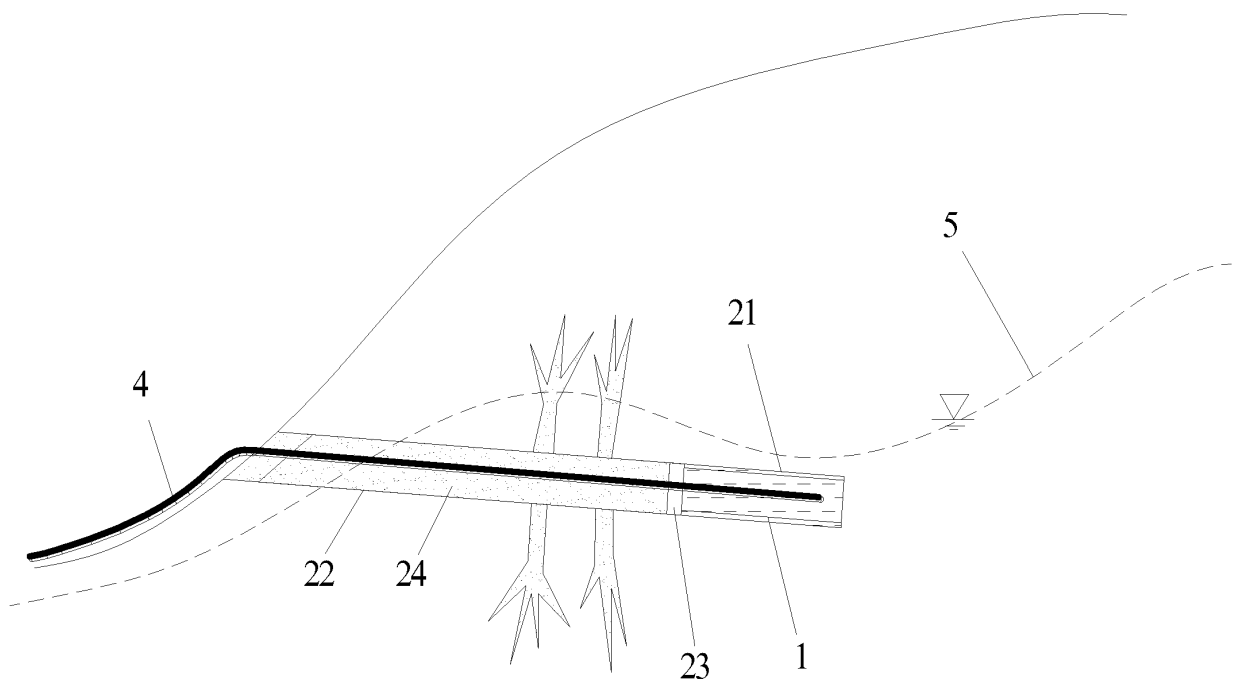


Fig 2

REFERENCES CITED IN THE DESCRIPTION

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