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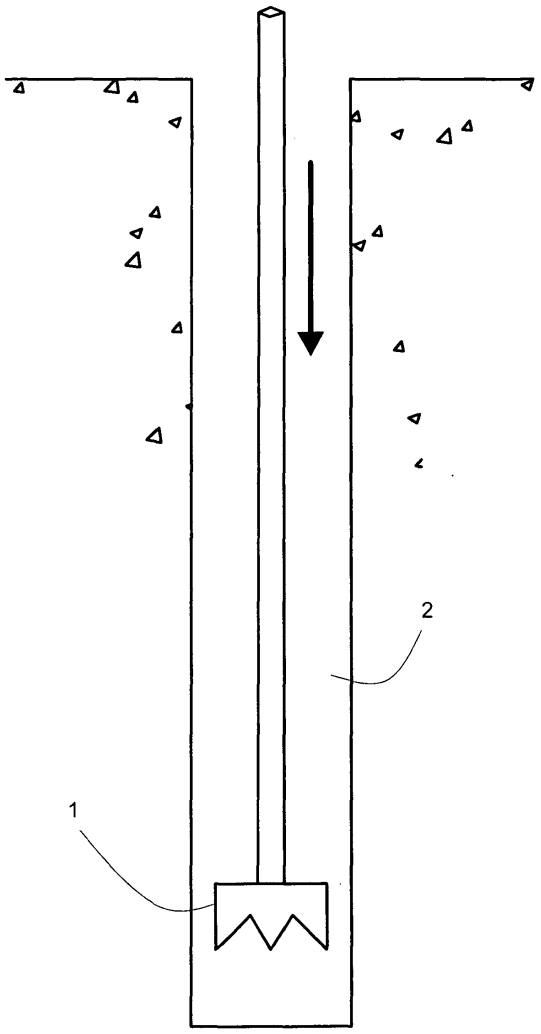
(54) Soil improvement process using jet grouting which provides high grouting material savings

(57) The invention finds application in the field of soil improvement processes and particularly relates to a process known as "jet grouting" in which a mixture of cement and water is injected in the soil under high pressure (above 200 bar). The process of this invention includes: a first simple drilling step using a downwardly advanced tool for exploration of the soil to be stabilized; a second soil precutting step across an area of the same size as the intended stabilization area, such precutting step being performed using a downwardly advanced tool and high pressure water and air jetting; a third grouting step by high pressure jetting of a mixture of cement or grouting material, using a tool which is moved upwards and outwards from the bottom; such third step is carried out while monitoring the material flowing out of the hole formed in the first drilling step.

FIG 1



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Description

[0001] The present invention relates to a soil improvement process using jet grouting, which provides considerable savings in grouting material, hereafter referred to as grout.

[0002] The soil improvement process known in the art as jet grouting is known to require in situ mixing of soil with a grout (usually a mixture of water and cement), which is injected therein under high pressure (above 200 bar).

[0003] This process destroys the soil matrix and creates a mixture of grout and soil to form a homogeneous and continuous element having predetermined characteristics.

[0004] A variety of soil improvement mixtures may be formed, by changing the type of grouting mixture depending on the soil type or by changing the angles of rotation of the tool or not rotating it at all, or the tool withdrawal time.

[0005] This may substantially provide cylindrical columns by continuous 360° rotation of the tool in combination with an upward vertical translation thereof, or quasi-rectangular panels by withdrawing the tool without rotating it.

[0006] Pressures of up to 400-600 bar are currently used.

[0007] In prior art a mixture of water and cement is injected under high pressure during withdrawal of the tool to form the desired volume.

[0008] This prior art method involves considerable cement waste, because during injection most of the injected material overflows due to an un unbalance between the injected volume and the volume to be stabilized.

[0009] The object of this invention is to dramatically reduce cement consumption during injection, while providing larger stabilized columns or panels.

[0010] These objects and advantages are fulfilled thanks to the process of this invention, which is characterized as claimed in the annexed claims and particularly in that it includes a step of high pressure water injection as the tool is advanced downwards to form a substantially cylindrical chamber if the tool is rotated or a quasi-rectangular chamber if panels are to be obtained without rotation, in which the stabilization mixture is to be injected.

[0011] These and other features will be more apparent upon reading the following description of the process, which is shown by way of example and without limitation in the accompanying drawings, in which:

- Figure 1 is a diagrammatic view of the first step of the process, which is referred to as exploration drilling;
- Figure 2 is a diagrammatic view of the second step of the process, which is referred to as precutting;
- Figure 3 is a diagrammatic view of the third step of the process, which is referred to as grouting.

[0012] Referring to Figure 1, the soil is drilled 2 to a desired depth using a traditional tool 1, in a so-called exploration drilling step.

[0013] This step, which is strictly necessary for particular soils, where the presence of particularly hard layers is expected, may be eliminated with easily drillable soils.

[0014] Next, as shown in Figure 2, water is injected under very high pressure (above 400 bar) by at least one nozzle 3, preferably two nozzles.

[0015] During this step, which is carried out with the tool advancing downwards, a chamber 4 is created, which contains a volume of water and disaggregated soil; with the very high pressure water jet, air is also injected.

[0016] Next, as shown in Figure 3, a third grouting material injection step, or grouting proper, is carried out, in which a grouting material (cement) is injected at a pressure above 100 bar from the bottom of the chamber 4 that is formed in step two.

[0017] During this step, the volume of grouting material that flows up from the bottom of such chamber, with the help of the gas phase, fills the whole volume created before, and pushes upwards the water and soil decompressed and precut in the previous step until they flow out.

[0018] The flow rate of injected cement or grouting material is of the order of 400 liters per minute or more.

[0019] By monitoring the overflow of water and soil, it is possible to determine when the volumes are firmly stabilized, especially to meet the design requirements; particularly, the increased density due to the presence of grout in said overflow material is measured with respect to the density of the soil during the cutting step.

[0020] The injection ends regardless of the level reached by the tool, when such density and, consequently, the amount of grout therein is constant and compliant with design requirements.

[0021] The above process clearly allows to considerably reduce the use of grouting material (grout), by minimizing the overflow material and larger volumes may be obtained than with prior art process, thanks to the formation of a pre-chamber, in step two, which is filled by jet grouting during withdrawal from the bottom thereof during step three. Since this step may be stopped without withdrawing the tool all along its operating height, production times may be apparently reduced.

Claims

1. Soil improvement process using jet grouting which provides high grouting material savings, **characterized in that** it includes: a so-called precutting step by high pressure water injection to the desired depth to create a chamber of desired volume, substantially equal to the desired stabilization volume; a subsequent step of high pressure injection of grouting material from the bottom of the chamber created in the preceding step towards the ground.

2. A process as claimed in claim 1, **characterized in that** it includes an exploration drilling step, which is carried out before the two steps as defined in claim 1.

3. A process as claimed in claim 1, **characterized in that** the precutting step uses water at a pressure above 400 bar.

4. A process as claimed in claim 1, **characterized in that** air is also injected during the precutting step.

5. A process as claimed in claim 1, **characterized in that** the precutting step is carried out using a downwardly advanced tool.

6. A process as claimed in claim 1, **characterized in that** the precutting step is started at a given depth.

7. A process as claimed in claim 1, **characterized in that** a pressure above 100 bar is used during the grouting material injection step.

8. A process as claimed in claim 1, **characterized in that** a volume of grouting material above 400 liters per minute is injected.

9. A process as claimed in claim 1, **characterized in that** air is also injected during the grouting material injection step.

10. A process as claimed in claim 1, **characterized in that** the density of the overflowing material is monitored during the grouting step.

11. A process as claimed in claim 1, **characterized in that** grouting material injection ends when the density of the overflowing material is constant and compliant with design requirements.

FIG 1

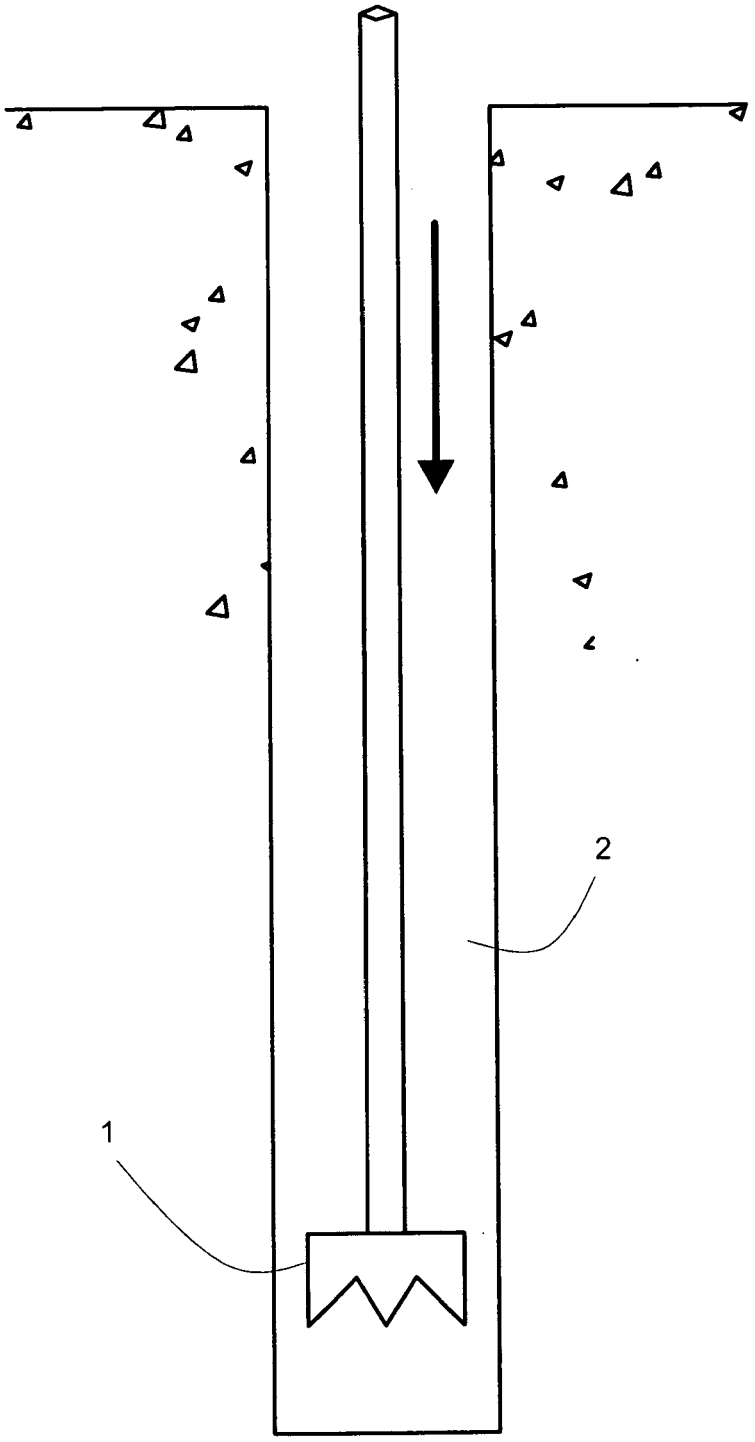


FIG 2

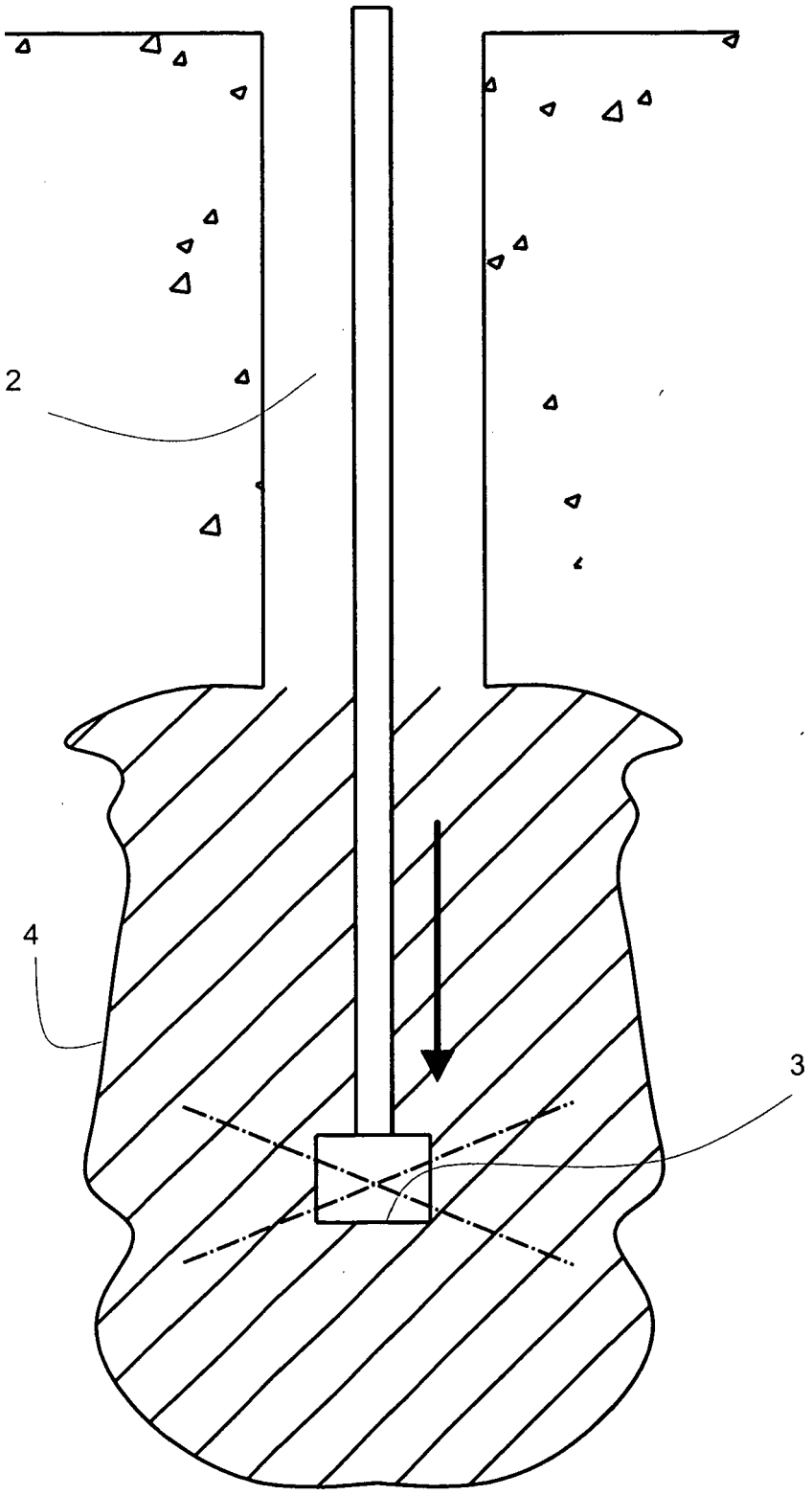
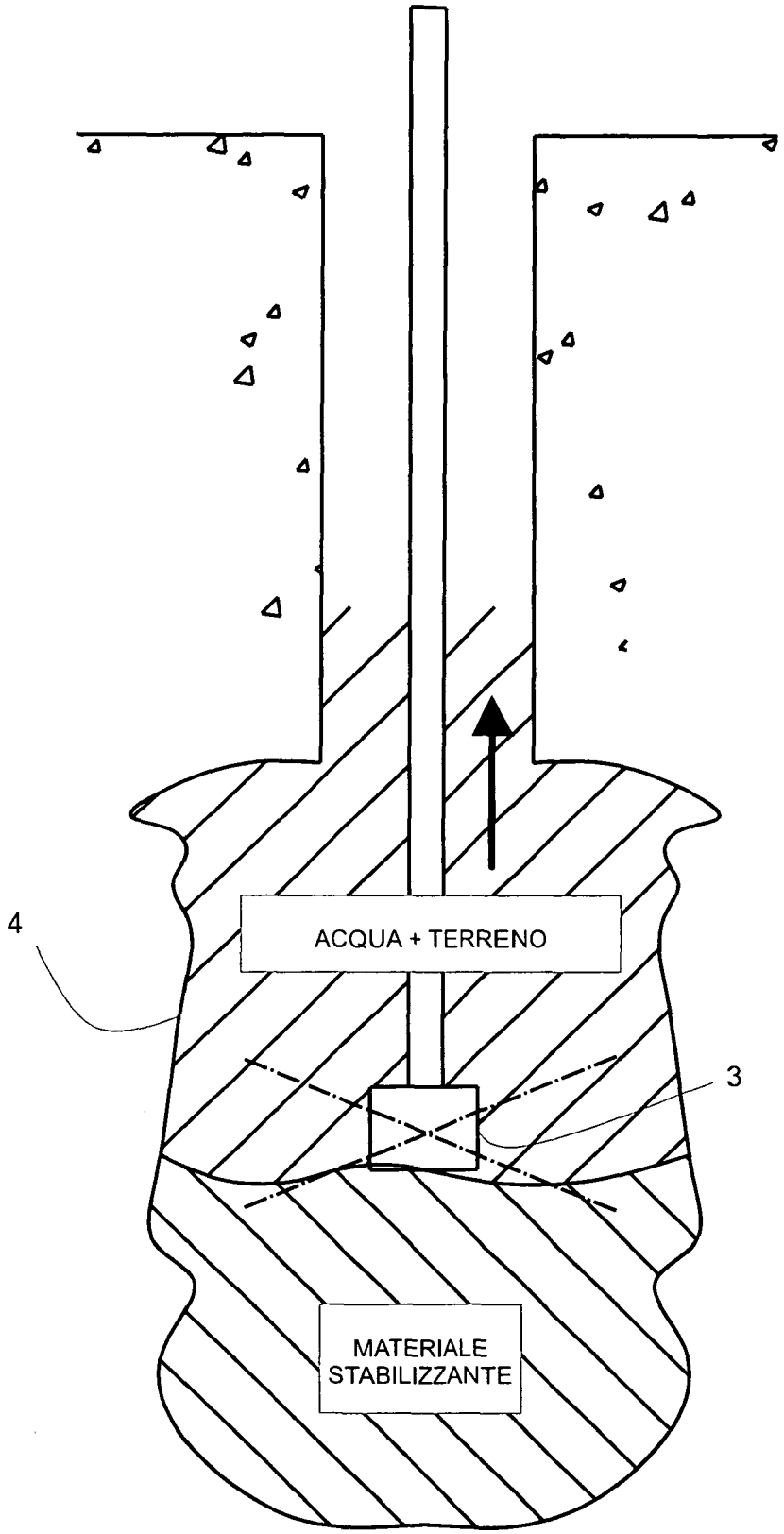


FIG 3



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EUROPEAN SEARCH REPORT

Application Number
EP 06 02 4991

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 March 2007	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

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