Title: SOIL IMPROVING AGENT INCLUDING SOIL HARDENING AGENT AND GROUND IMPROVING AGENT, SOIL IMPROVING METHOD INCLUDING SOIL HARDENING METHOD AND GROUND IMPROVING METHOD, AND IMPROVED GROUND

Abstract: A soil improving agent comprising malic acid and/or grape sugar is mixed with soil to enable the ground after consolidation to have good water permeability and strength.
DESCRIPTION

Soil Improving Agent Including Soil Hardening Agent and Ground Improving Agent, Soil Improving Method Including Soil Hardening Method and Ground Improving Method, And Improved Ground

Technical Field

The present invention relates to soil improvement technology used in various applications such as road construction, land development and the reinforcement of embankment slopes, and in particular relates to a soil improving agent including a soil hardening agent and a ground improving agent, a soil improving method including a soil hardening method and a ground improving method, and an improved ground which makes it possible to solve the problems associated with secondary damage such as soil contamination and groundwater contamination due to various earthworks, and which makes it possible to harden the surface of easily scattered soil in order to prevent wind damage.

Background Art

In the prior art, because soil strength is increased by means of an aggressive improvement method using soil improvement materials such as cement-type hardening agents which include heavy metals, large quantities of lime and large quantities of normal cement, this creates problems including secondary damage such as soil contamination and groundwater contamination.

Namely, the use of such prior art soil improving materials has the following disadvantages:
1. When a cement-type hardening agent which includes heavy metals is used, the soil becomes contaminated by the heavy metals. Further, these heavy metals can also contaminate the groundwater.

2. When large quantities of lime and normal cement are used, operations can be hazardous due to the large quantity of heat generated. Further, after hardening has taken place, an unstable structure is created due the occurrence of cracks and the like. Moreover, because a complete mixing of cement and the like is difficult to achieve, the resulting structure lacks uniformity. Furthermore, in the case where lime and ordinary cement are used, the soil itself is killed, and after hardening of the cement and the like, the water permeability deteriorates and a weak stratum is created in the boundary where such soil improvement materials are used. Consequently, these prior art soil improving materials are considered to be inadequate.

3. When lime and ordinary cement are used, these materials require the mixing of large amounts of powdered materials, and this creates dust problems.

4. When lime and ordinary cement are used, because no improvement of the organic soil characteristics are achieved for the soil particles themselves, there is a rough improvement in density, but because there are few gaps between the soil particles, the improved ground has poor water permeability, and as a result, the soil structure lacks uniform strength.

25 Disclosure of Invention

In view of the problems of the prior art described above, it is an object of the present invention to provide an improved soil, a soil improving agent including a soil hardening agent and a ground improving
agent, and a soil improving method including a soil hardening method
and a ground improving method, and an improved ground which makes it
possible to solve the problems of soil contamination and groundwater
contamination, which makes it possible for hardened ground to have good
water permeability, and which makes it possible to harden the ground
while keeping the soil alive in a natural state in order to increase the
strength of the soil and prevent wind damage.

In order to achieve the object stated above, malic acid and/or grape
sugar are used as the main components of the soil hardening agent and the
ground improving agent which comprise the soil improving agent of the
present invention. The amount of these components of the soil
improving agent are changed in accordance with the acidity, alkalinity,
metal content and inorganic matter content of the soil. Preferably, such
components of the soil improving agent are in the form of a liquid or
powder. Further, the soil improving agent may include an assisting agent
such as sodium chloride or sodium hydrogencarbonate.

In one embodiment of the soil improving method which includes a
soil hardening method and a ground improving method according to the
present invention, soil is mixed with a soil improving agent comprising
malic acid and/or grape sugar, and then after mixing, a pressure hardening
is carried out.

In another embodiment of the soil improving method which
includes a soil hardening method and a ground improving method
according to the present invention, a soil improving agent comprising
malic acid and/or grape sugar is spread uniformly over the surface of the
soil, and then only the surface of the soil is subjected to hardening.

The improved ground according to the present invention comprises
a consolidation hardened mixture of soil and a soil improving agent having
malic acid and/or grape sugar as a major component to provide good water permeability and strength.

**Principle and Operation**

When the soil improving agent of the present invention is used to improve a soil, the malic acid and/or grape sugar molecules migrate toward each of the organic soil particles and form a covering on the surfaces thereof, whereby the soil particles form separate inorganic particles having a well-ordered arrangement. Then, after pressure is applied to carry out consolidation, the ground obtained thereby has good water permeability and strength.

In this regard, depending on the properties of the soil, there are cases where it is possible to use only malic acid or only grape sugar as the main component of the soil improving agent, but the use of both malic acid and grape sugar is preferred because such combination makes it possible to carry out a smooth hardening of the soil. Namely, malic acid or grape sugar has an affinity to the organic portions, and malic acid or grape sugar covers the surroundings thereof.

Further, the soil improving agent may be used in liquid or powdered form depending on the specific requirements of the soil, and as described above, the soil improving agent of the present invention is used as a soil hardness improving material.

For example, in the case where the obstructing component of the soil is soft organic matter, because the malic acid covers the organic soil particles to form inorganic particles which are held together by the grape sugar, the soil is not destroyed during pressure consolidation. Further, the use of malic acid and/or grape sugar makes it possible to prevent damage due to cracking and the like, and makes it possible to easily
improve the soil while preserving the natural state thereof.

Furthermore, by spreading the soil improving agent of the present invention over the surface of a soil and then compacting only the surface of such soil, it is possible to easily cure the soil to prevent the soil matter from being scattered.

Best Mode of Carrying Out the Invention

**Embodiment 1**

Thirty two liters of a 2% soil improving agent solution comprising 15g of malic acid and 10g of grape sugar per liter of water was added to and mixed with a soil containing organic matter and having a density of 1.6 ton/m³, and then rollers were used to compact the mixture to obtain an improved ground having a consolidated structure. The obtained improved ground was determined to have good water permeability and strength.

**Embodiment 2**

Sodium hydrogen carbonate was added to a weak ground having a high water content soil comprised of sludge and the like to remove the water between the soil particles and thereby lower the water content. Next, a soil improving agent comprised of a mixture of malic acid and grape sugar in the form of a granulated powder was added to and mixed with the soil, and then rollers were used to compact the mixture to obtain an improved ground having a consolidated structure. The obtained improved ground was determined to have good water permeability and strength.

**Embodiment 3**

In the case where the slope of an embankment is to be reinforced, a soil improving agent solution comprised of 30g of malic acid and 50g of
grape sugar per liter of water is spread uniformly over the surface of an easily scattered soil (e.g., the top soil in road construction, land development, etc.), and then by hardening only the surface of the soil, it is possible to easily cure the soil and prevent the soil particles from being scattered by wind and the like.

The soil improving agent of the present invention is harmless to people and animals, and as described above, when the soil improving agent is mixed with the soil or distributed on the surface of the soil, the organic soil particles become covered and separated from each other. Then, when these separated soil particles are consolidated, the grape sugar and/or malic acid binds the soil particles together, and the soil is kept alive in a natural state. Further, because water permeability can be maintained while hardening the soil, and because the strength of the soil is increased, the soil improvement achieved by the present invention is extremely reliable.

Namely, the soil improving agent including a soil hardening agent and a ground improving agent, the soil improving method including a soil hardening method and a ground improving method, and the improved ground according to the present invention eliminates the problem of soil contamination, maintains good water permeability for consolidated ground, and increases the strength of the soil while keeping the soil alive in a natural state.

Furthermore, by uniformly spreading the soil improving agent of the present invention over the surface of a soil and then hardening only such soil surface, it becomes possible to easily cure the soil and prevent the soil particles from being scattered by wind and the like.
CLAIMS

1. A soil improving agent, comprising:
   malic acid and/or grape sugar.

2. The soil improving agent of Claim 1, wherein the soil improving agent
   is in the form of a liquid or powder.

3. The soil improving agent of Claim 1 or Claim 2, further comprising
   a soil assisting agent including sodium chloride or sodium
   hydrogen carbonate.

4. A soil improving method, comprising the steps of:
   mixing a soil and a soil improving agent including malic acid
   and/or grape sugar; and
   pressure hardening the mixture of soil and soil improving agent
   after the mixing step.

5. A soil improving method, comprising the steps of:
   spreading a soil improving agent including malic acid and/or grape
   sugar uniformly over the surface of a soil; and
   hardening the surface of the soil after the spreading step.

6. An improved ground, comprising:
   a soil; and
   a soil improving agent including malic acid and/or grape sugar;
   wherein the soil and the soil improving agent are mixed and
   hardened by consolidation.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C09K17/14 C09K17/16 C09K17/40

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbol)

IPC 7 C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

COMPEXDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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| X        | DATABASE WPI
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          | Derwent Publications Ltd., London, GB;
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          | -/-- |

Further documents are listed in the continuation of box C.

Date of the actual completion of the international search

10 November 2000

Date of mailing of the international search report

22/11/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
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*C* document referring to an oral disclosure, use, exhibition or other means

*P* document published prior to the international filing date but later than the priority date claimed

**T** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**X** document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Form PCT/ISA/20 (second sheet) (July 1992)

page 1 of 2
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