US 20170138012A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0138012 A1**

HORIE et al. (43) **Pub. Date: May 18, 2017**

(54) **METHOD FOR SLOPE IMPROVEMENT**

(71) Applicant: **DYFLEX CORPORATION**, Tokyo (JP)

(72) Inventors: **Kazuyuki HORIE**, Tokyo (JP); **Katsuhiro HIGASHI**, Tokyo (JP); **Takeyasu MASUDA**, Tokyo (JP)

(73) Assignee: **DYFLEX CORPORATION**, Tokyo (JP)

(21) Appl. No.: **15/323,917**

(22) PCT Filed: **Jul. 6, 2015**

(86) PCT No.: **PCT/JP2015/069432**

§ 371 (c)(1),
(2) Date: **Jan. 4, 2017**

(30) **Foreign Application Priority Data**

Jul. 4, 2014 (JP) 2014-138999

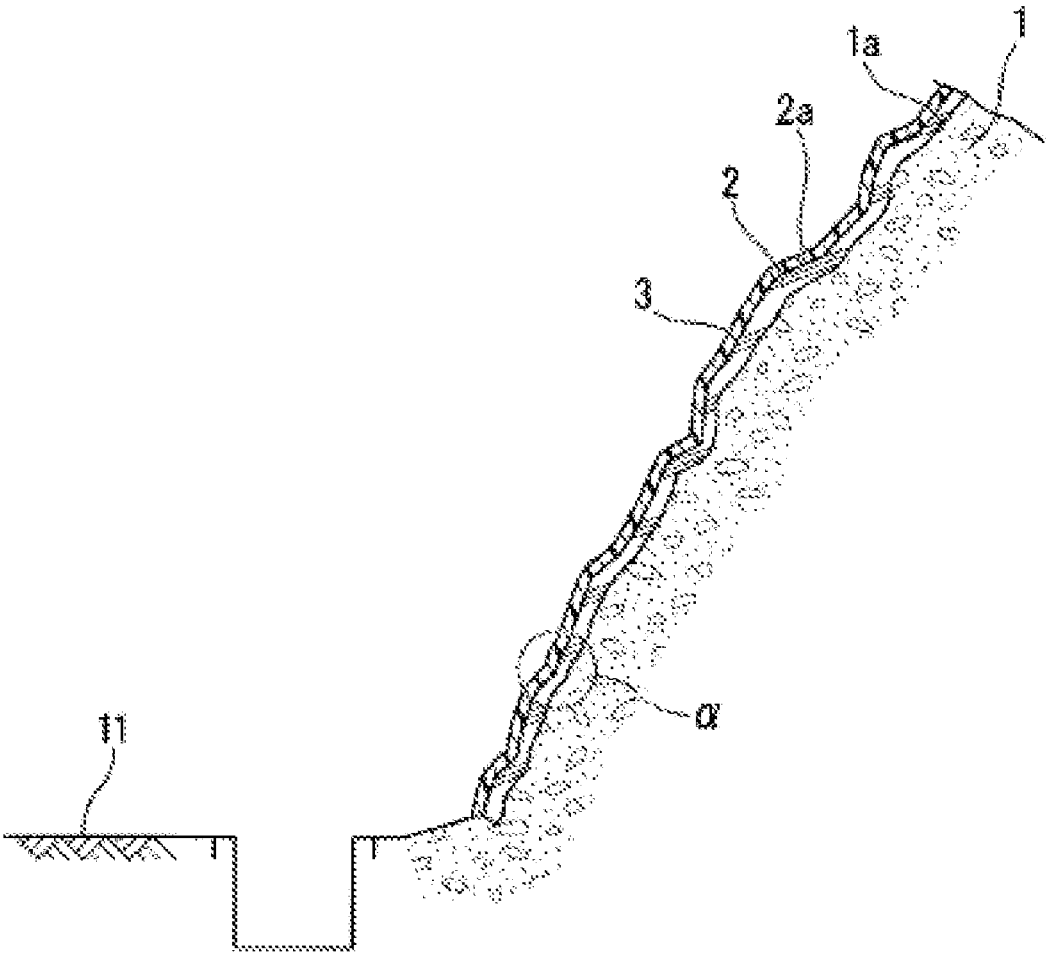
Publication Classification

(51) **Int. Cl.**
E02D 17/20 (2006.01)

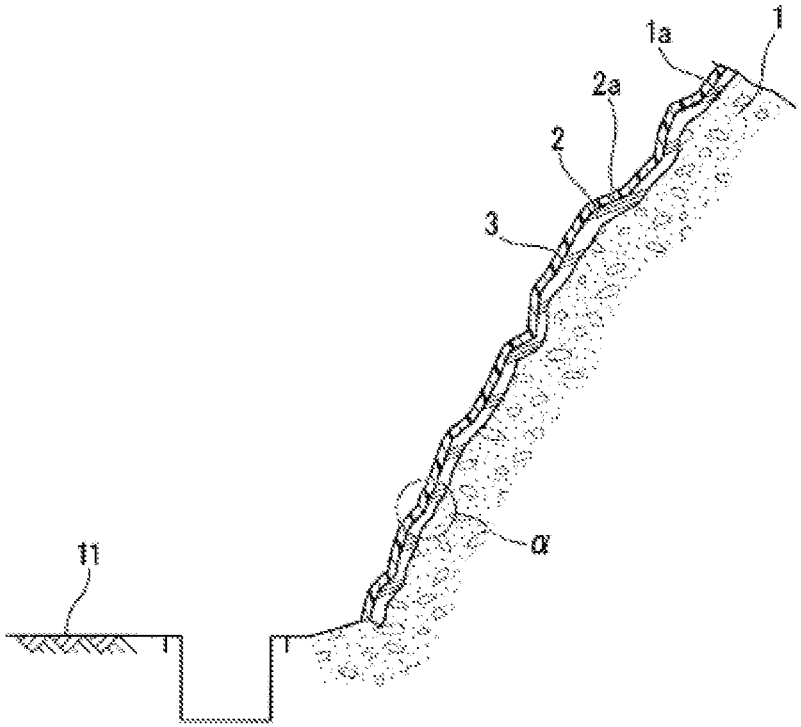
(52) **U.S. Cl.**
CPC ***E02D 17/20*** (2013.01); *E02D 2300/002* (2013.01); *E02D 2300/0021* (2013.01); *E02D 2300/007* (2013.01); *E02D 2600/40* (2013.01)

(57) **ABSTRACT**

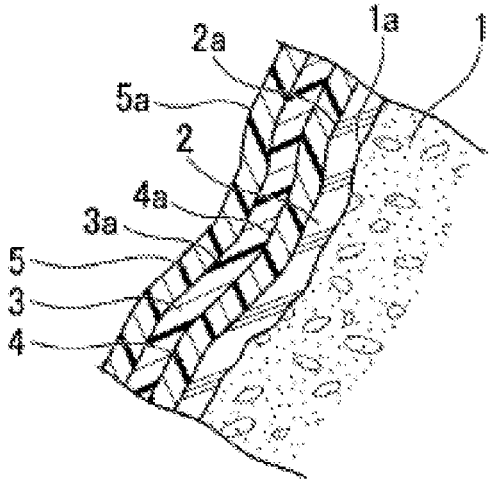
A method for slope improvement including layering a life-extending layer on the surface of a protective layer made from mortar or concrete sprayed onto a slope in order to prevent rain water or the like from entering cracks in the protective layer, inhibit degradation of the protective layer, and prevent mortar pieces or concrete pieces from spalling off the protective layer, the method for slope improvement being characterized in that the life-extending layer is formed by a coating layer that has a crack conformability of 0.8 mm or larger and has salt-blocking properties and neutralization-preventing properties.



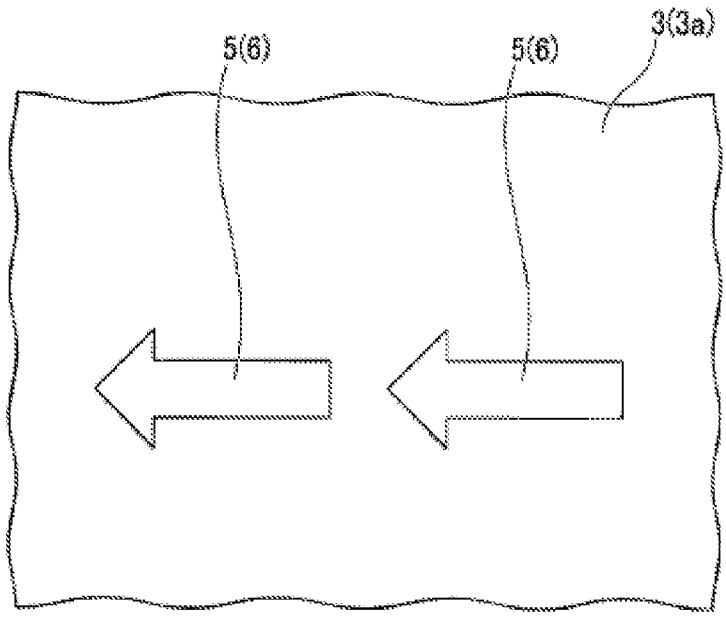
[Fig. 1]



[Fig. 2]



[Fig. 3]



METHOD FOR SLOPE IMPROVEMENT

TECHNICAL FIELD

[0001] The present invention relates to a method for slope face improvement, which prevents penetration of rainwater and the like from cracks that form in a protective layer comprising mortar or concrete sprayed onto a slope face, restricts degradation such as salt damage or neutralization of the protective layer, and also prevents detachment of the protective layer.

[0002] This application claims priority on the basis of Japanese Patent Application 2014-138999 filed in Japan on Jul. 4, 2014 the content of which is cited herein.

PRIOR ART

[0003] Mortar or concrete (also referred to below as "mortar etc.") is sprayed onto cliff faces and slope faces which have degraded due to weathering and the like, in order to protect the cliff face or the slope face and to prevent instability of the faces, and a protective layer comprising mortar or concrete is provided on said faces (e.g., see Patent Document 1). Forms of cliff face or slope face instability which may be cited include slides caused by erosion, surface-layer crumbling, and collapse. A protective layer comprising mortar etc. is provided in order to prevent this kind of instability from occurring. The construction method involving providing this kind of protective layer is one of the methods most often used because not only does it provide a strong blocking effect with respect to weather, temperature changes and seepage water, it also has excellent properties in terms of construction

PRIOR ART DOCUMENT

Patent Document

[0004] Patent Document 1: JP 2013-1585 A

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

[0005] In this regard, Japan has a large number of cliff faces and slope faces, and in recent years there have not only been collapses of slope faces and oblique faces as a result of frequent intensive rainfall and natural disasters, there has also been loss of human life. The collapse of slope faces etc. impedes rescuing people and disaster relief. One cause of the collapse of slope faces etc. that may be cited is due to the fact that rainwater etc. penetrates into cracks formed as a result of degradation over time of the protective layer comprising mortar etc. sprayed onto said slope faces etc., and the rainwater erodes the rear surface of the protective layer. As a result, cavities are formed between the foundation and the protective layer, and this may lead to crumbling of the protective layer.

[0006] Examples of the causes of degradation of the protective layer comprising mortar etc. which may be cited include: (1) penetration of rainwater from cracks produced by degradation over time; (2) frost damage; and (3) chemical erosion (salt damage (calcium chloride) and neutralization (carbon dioxide) etc.).

[0007] When the protective layer degrades, adhesion between the protective layer and the foundation (slope face) is lost over time to produce a floating state, and this causes a phenomenon in which cracks are further enlarged as the foundation becomes looser. Furthermore, degradation of the protective layer over time is also caused by a phenomenon in which vegetation enters surface-layer areas of the protective layer where sedimentation has occurred, and this pushes the cracks wider apart.

[0008] Frost damage to the protective layer is a phenomenon in which free water in the protective layer comprising mortar etc. and moisture in the aggregate which has high water absorption are repeatedly subjected to a freezing and thawing action, whereby cracks are formed in the protective layer, the surface layer portion of the protective layer peels, and breakage occurs from the area close to the surface, causing gradual degradation.

[0009] Salt damage in the protective layer constitutes the following phenomenon. During the winter period, snow-melting agents such as calcium chloride are scattered on road surfaces in mountainous regions in order to prevent freezing of roads due to snow. When a motor vehicle or the like travels on a road surface on which a snow-melting agent has been scattered and when the wind blows, the snow-melting agent is dispersed and may adhere to the protective layer formed on a cliff face or a slope face. When the snow-melting agent adheres to the protective layer, steel material in the protective layer corrodes and cracks form from inside the protective layer due to volume expansion, so the mortar etc. becomes detached. The mortar etc. is likely to degrade in this way because of the snow-melting agents, and therefore the protective layer has a short lifespan in mountainous regions and the mortar etc. has to be frequently sprayed, which increases the cost entailed in stabilizing cliff faces and slope faces.

[0010] Neutralization of the protective layer is a phenomenon in which carbon dioxide (CO_2) in the atmosphere penetrates into the mortar etc., causing a carbonation reaction which reduces the pH of the mortar etc. which is essentially alkaline. When neutralization progresses from the surface of the protective layer and reaches the steel material present within the protective layer, this damages the passivation film. As a result, the steel material corrodes and cracks are formed in the protective layer due to volume expansion of the corroded material formed, and the protective layer becomes detached.

[0011] The present invention has been devised in light of the situation described above, and the aim thereof lies in providing a method for slope face improvement which prevents penetration of rainwater and the like from cracks that form in a protective layer comprising mortar or concrete sprayed onto a slope face, restricts degradation such as salt damage or neutralization of the protective layer, and also prevents detachment of the protective layer caused by the degradation.

Means for Solving the Problem

[0012] A method for slope face improvement according to one mode of the present invention (referred to below as "the method for slope face improvement according to the invention of this application") is a method in which a lifespan-extending layer is layered on a surface of a protective layer comprising mortar or concrete sprayed on a slope face, whereby penetration of rainwater etc. from cracks that form in the protective layer is prevented, degradation of the protective layer is restricted, and detachment of mortar pieces or concrete pieces from the protective layer is pre-

vented, said method being characterized in that a coating layer having crack-following properties of 0.8 mm or greater, salt-blocking properties and neutralization-preventing properties is formed as the lifespan-extending layer.

[0013] According to the method for slope face improvement of the present invention, the coating layer preferably comprises a polymer compound.

[0014] According to the method for slope face improvement of the present invention, a primer layer is preferably formed between the protective layer and the lifespan-extending layer.

[0015] According to the method for slope face improvement of the present invention, a topcoat layer is preferably formed on the lifespan-extending layer.

[0016] According to the method for slope face improvement of the present invention, the polymer compound is preferably at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

Advantage of the Invention

[0017] According to the present invention, a coating layer having crack-following properties of 0.8 mm or greater, salt-blocking properties and neutralization-preventing properties is formed as a lifespan-extending layer on the surface of a protective layer comprising mortar or concrete sprayed on a slope face, and as a result, it is possible to prevent penetration of rainwater and the like from cracks that form in the protective layer, restrict degradation such as salt damage or neutralization of the protective layer, and also prevent detachment of the protective layer caused by the degradation; it is thus possible to envision a longer lifespan for the protective layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. **1** is a schematic diagram illustrating the method for slope face improvement according to a mode of embodiment, and shows a cross section parallel to the height direction of terrain having a cliff face or a slope face;

[0019] FIG. **2** is a schematic diagram illustrating the method for slope face improvement according to a mode of embodiment, shows a cross section parallel to the height direction of terrain having a cliff face or a slope face, and is an enlargement of part of FIG. **1**; and

[0020] FIG. **3** is a front view illustrating an example of the method for slope face improvement according to a mode of embodiment, in which visual guidance serving as a safety measure is provided by a topcoat layer.

MODE OF EMBODIMENT OF THE INVENTION

[0021] A mode of embodiment of the method for slope face improvement according to the present invention will be described.

[0022] It should be noted that this mode of embodiment is specifically described in order to provide a better understanding of the essential point of the present invention and does not limit the present invention unless particularly indicated otherwise.

[0023] FIG. **1** is a schematic diagram illustrating the method for slope face improvement according to this mode of embodiment, and shows a cross section parallel to the height direction of terrain having a slope face. FIG. **2** is a schematic diagram illustrating the method for slope face improvement according to this mode of embodiment, shows a cross section parallel to the height direction of terrain having a slope face, and is an enlargement of part of FIG. **1**.

[0024] In FIG. **1** and FIG. **2**, the reference symbol **1** denotes a foundation, **1***a* denotes a slope face (cliff face), **2** denotes a protective layer comprising mortar or concrete; **3** denotes a lifespan-extending layer; **4** denotes a primer layer; and **5** denotes a topcoat layer. It should be noted that the primer layer **4** and the topcoat layer **5** may be used as required.

[0025] The method for slope face improvement according to this mode of embodiment is a method in which the lifespan-extending layer **3** is layered on a surface **2***a* of the protective layer **2** comprising mortar etc. sprayed on the slope face **1***a* of the foundation **1**, whereby penetration of rainwater etc. from cracks that form in the protective layer **2** is prevented, degradation of the protective layer **2** is restricted, and detachment of mortar pieces or concrete pieces from the protective layer **2** is prevented, a coating layer having crack-following properties of 0.8 mm or greater, salt-blocking properties and neutralization-preventing properties being formed as the lifespan-extending layer **3**.

[0026] The lifespan-extending layer **3** sustains and reinforces the protective layer **2** and thereby extends the lifespan (useful life) thereof (prolongs the life thereof).

[0027] The protective layer **2** is a layer comprising conventional mortar or concrete which is sprayed in order to protect the slope face **1***a* of the foundation **1** and to prevent the slope face **1***a* from become unstable.

[0028] It should be noted that the slope face **1***a* may equally be a cliff face when the foundation **1** is a cliff.

[0029] The coating layer forming the lifespan-extending layer **3** has crack-following properties of 0.8 mm or greater, as defined in Structure Construction Management (July 2015 edition, 3-6: Concrete, 3-6-2: Surface Protection Requirement Performance, Nippon Expressway Research Institute Company Limited), and preferably 5 mm or greater, more preferably between 1 mm and 10 mm.

[0030] If the crack-following properties have a value of less than 0.8 mm, the crack-following properties of the coating layer with respect to changes caused by degradation over time of the protective layer **2** comprising mortar etc. are inadequate, and it is not possible to obtain an adequate effect in terms of the lifespan of the protective layer **2** afforded by the lifespan-extending layer **3**.

[0031] The coating layer forming the lifespan-extending layer has salt-blocking properties of no greater than 3.7×10^{-5} mg/cm^2·day, as defined in the "Quality Standard Test Method JHS 417-1999 for Concrete Coating Materials" of Structure Construction Management of the Japan Highway Public Corporation, and the coating layer has excellent salt-blocking properties if the defined value satisfies no greater than 5.0×10^{-3} mg/cm^2·day. That is to say, the coating layer which is a reinforcing layer **3** has a considerable effect in terms of blocking salts such as calcium chloride used as a snow-melting agent, and can prevent corrosion of the protective layer **2** caused by said salts.

[0032] The coating layer forming the lifespan-extending layer **3** is such that the neutralization-preventing properties defined in Structure Construction Management (July 2015 edition, 3-6: Concrete, 3-6-2: Surface Protection Require-

ment Performance, Nippon Expressway Research Institute Company Limited), are 1 mm or less in terms of neutralization depth.

[0033] The thickness of the lifespan-extending layer **3** is preferably 1 mm to 2 mm.

[0034] If the thickness of the lifespan-extending layer **3** is within this range, it is possible to achieve salt-blocking properties in the lifespan-extending layer **3** of no greater than 3.7×10^{-5} mg/cm^2·day.

[0035] The coating layer forming the lifespan-extending layer **3** preferably comprises a polymer compound able to satisfy the abovementioned crack-following properties, salt-blocking properties and neutralization-preventing properties.

[0036] Furthermore, the polymer compound is preferably at least one selected from the group consisting of: acrylic resin, epoxy resin, polyester resin, polyurethane resin, polyurea resin, acrylic urethane resin, asphalt urethane resin and asphalt.

[0037] These polymer compounds may be used alone or two or more types may be mixed for use.

[0038] For example, when a slope face **1** facing a road is constructed, a preferred polymer material which may be used is an ultra-fast-curing polyurethane resin or polyurea resin etc. which constitutes a material that cures rapidly, in order to shorten construction time and lift lane restrictions on a road caused by one-way traffic.

[0039] The lifespan-extending layer **3** is constructed over a large surface area with respect to the slope face **1***a* of the foundation **1**, and therefore it is necessary to form the lifespan-extending layer **3** efficiently. The curing time after spraying of mortar etc. is between 4 and 28 days, so it is difficult to shorten the construction time. In contrast to this, ultra-fast-curing polyurethane resin or polyurea resin has a curing time after coating of 1 day, and therefore it is possible to shorten the construction time. It is therefore possible to efficiently construct the lifespan-extending layer **3** on the slope face **1***a* of the foundation **1** by using an ultra-fast-curing polyurethane resin or polyurea resin.

[0040] There is no particular limitation as to the method for applying the coating layer that forms the lifespan-extending layer **3** on the surface **2***a* of the protective layer **2** or on a surface (referred to below as "the surface") **4***a* on the opposite side to the face of the primer layer **4** in contact with the protective layer **2**, but according to an exemplary method which may be cited, a coating composition comprising a polymer compound that forms the coating layer is applied to the surface **2***a* of the protective layer **2** or to the surface **4***a* of the primer layer **4** by means of a two-liquid impact agitation/mixing-type spray gun or a static mixer-type spray gun. In particular, when an ultra-fast-curing polyurethane resin is applied by means of a spray gun, the coating film may be formed by supplying to the spray gun a curable mixture obtained by mixing an isocyanate component and a polyol component, and applying this to the surface **2***a* of the protective layer or the surface **4***a* of the primer layer **4**, or the isocyanate component and the polyol component may be separately supplied to the spray gun, and a mixture obtained by mixing of said components inside the spray gun may be applied to the surface **2***a* of the protective layer **2** or to the surface **4***a* of the primer layer **4** in order to form the coating layer.

[0041] The primer layer **4** preferably has affinity with the lifespan-extending layer **3** and the protective layer **2** comprising mortar etc., and there may also be cases in which the surface **2***a* of the protective layer **2** is whetted, so said primer layer is preferably able to bond to a wet surface. Specific examples of primers forming the primer layer **4** which may be advantageously used include primers comprising epoxy resin or urethane resin which cures at normal temperature, and these primers may be single-liquid curable primers or two-liquid curable primers.

[0042] Furthermore, the primer layer **4** may be omitted if there is adequate bonding between the protective layer **2** and the lifespan-extending layer **3**.

[0043] The topcoat layer **5** is formed with the aim of protecting the lifespan-extending layer **3** (improving the weatherability thereof), harmonizing with the landscape and providing visual guidance serving as a safety measure. Examples of the polymer compound forming the topcoat layer **5** which may be used include a two-liquid curable solvent-based acrylic urethane resin, a two-liquid curable aqueous acrylic urethane resin, an aqueous acrylic resin, and an organo-siloxane resin.

[0044] The topcoat layer **5** is normally formed with the aim of protecting the lifespan-extending layer **3**, but as shown in FIG. **3**, it may equally be provided as a different-colored region **6** having a different color from the lifespan-extending layer **3**, on the opposite surface (referred to below as "the surface") **3***a* to the surface of the lifespan-extending layer **3** facing the protective layer **2**. As shown in FIG. **3**, the different-colored region **6** is depicted as an arrow or the like for visual guidance indicating the direction of travel on a road (see FIG. **1**) running along the slope face **1***a*. There is no particular limitation as to the shape, size (area) or number of different-colored regions **6**, and these may be suitably adjusted in accordance with the information (travel direction or warning about a slope failure, or landslide etc.) represented by said different-colored regions **6**.

[0045] Furthermore, when the different-colored region **6** is formed, a mixture in which a colored pigment commensurate with the aim is mixed with the polymer compound forming the topcoat layer **5** may be used, and said mixture may be applied to the surface **3***a* of the lifespan-extending layer **3** as a distinct color from the lifespan-extending layer **3** in order to form the different-colored region **6**.

[0046] There is no particular limitation as to the method for coating the polymer compound forming the topcoat layer **5** on the surface **3***a* of the lifespan-extending layer **3**, but examples of methods which may be cited include applying the polymer compound to the surface **3***a* of the lifespan-extending layer **3** by means of a roller, a brush or a spray gun et cetera.

[0047] According to the method for slope face improvement of this mode of embodiment, dirt and foreign material adhering to the surface **2***a* of the protective layer **2** comprising mortar etc. are first of all completely removed. Furthermore, if there are protrusions or differences in level etc. on the surface **2***a* of the protective layer **2**, said surface **2***a* is preferably smoothed by making combined use of power tools and manual tools.

[0048] In addition, after the whole of the region of the surface **2***a* of the protective layer **2** on which the lifespan-extending layer **3** is formed (the forming surface) has been smoothed, the forming surface is preferably cleaned by means of a brush or air blowing etc. in order to completely remove dirt and foreign material.

[0049] The primer layer **4** is then formed by coating a primer on the cleaned surface **2***a* of the protective layer **2**.

[0050] It should be noted that this mode of embodiment illustrates a case in which the primer layer **4** is provided, but this does not limit the present invention and it is equally possible to omit the primer layer **4** if adhesion between the protective layer **2** and the lifespan-extending layer **3** is adequate by virtue of the surface state of the surface **2***a* of the protective layer **2** etc.

[0051] A coating composition comprising the polymer compound constituting the coating layer that forms the lifespan-extending layer **3** is then coated on the surface **2***a* of the protective layer **2** or on the surface **4***a* of the primer layer **4**, and said coating composition is cured in order to form the lifespan-extending layer **3**.

[0052] The coating composition comprising the polymer compound that forms the topcoat layer **5** is coated on the surface **3***a* of the lifespan-extending layer **3**, and said coating composition is cured in order to form the topcoat layer **5**, whereby construction is completed.

[0053] According to the method for slope face improvement of this mode of embodiment, the coating layer having crack-following properties of 0.8 mm or greater, salt-blocking properties and neutralization-preventing properties is formed as the lifespan-extending layer **3** on the surface **2***a* of the protective layer **2** comprising mortar etc. sprayed on the slope face **1***a* of the foundation **1**, and as a result it is possible to prevent penetration of rainwater and the like from cracks that form in the protective layer **2**, restrict degradation such as salt damage or neutralization of the protective layer, and also prevent detachment of the protective layer caused by the degradation. Furthermore, the resulting lifespan-extending layer **3** makes it possible to prevent penetration of rainwater etc. from cracks that form in the protective layer **2**, and also has a punching strength of 0.3 kN or greater (Structure Construction Management (July 2015 edition, 3-6: Concrete, 3-6-2: Surface Protection Requirement Performance, Nippon Expressway Research Institute Company Limited)) which is able to prevent detachment of the protective layer **2**. Furthermore, the lifespan-extending layer **3** has a large effect in terms of blocking salts such as calcium chloride used as a snow-melting agent, so it is possible to prevent degradation of the protective layer **2** comprising mortar etc. caused by said salts. As a result, it is possible to prevent degradation of the protective layer **2** and detachmant of the mortar etc., and thus it is possible to envision a longer lifespan for the protective layer **2**.

[0054] Furthermore, according to the method for slope face improvement of this mode of embodiment, the different-colored region **6** is formed on the surface **3***a* of the lifespan-extending layer **3**, and as a result it is possible to provide a notification of information relating to the environment around the slope face **1***a* (travel direction on the road **11** running along the slope face **1***a*, warning about a slope failure or landslide etc.). Furthermore, by forming the lifespan-extending layer **3**, the protective layer **2** comprising mortar etc. is not directly exposed to wind and rain (snow and rain), so it is possible to prevent staining of the protective layer **2** and adhesion of contaminants, and therefore the esthetic appearance of the slope face **1***a* can be maintained.

EXEMPLARY EMBODIMENT

[0055] The present invention will be described in more specific terms below through an exemplary embodiment and comparative examples, but the present invention is not limited to the following exemplary embodiment.

Exemplary Embodiment

[0056] The surface of a protective layer comprising existing mortar that had deteriorated was cleaned in order to remove dirt and foreign material etc., after which a modified epoxy resin primer (commercial name: Resi-Primer PW-F, produced by Diflex) was applied over the protective layer in a coating amount of 0.2 kg/m^2, and a primer layer having a thickness of 65 μm was formed.

[0057] A two-liquid ultra-fast-curing polyurethane resin (commercial name: CV Spray, produced by Diflex) was then applied by means of a spray gun over the primer layer in a coating amount of 1.0 kg/m^2, and a lifespan-extending layer having a thickness of 1000 μm was formed.

[0058] A two-liquid solvent-based acrylic urethane resin (commercial name: Resi-Top, produced by Diflex) was then applied by means of a spray gun over the lifespan-extending layer in a coating amount of 0.15 kg/m^2, and a topcoat layer having a thickness of 47 μm was formed.

[0059] The features of the method for slope face improvement according to the exemplary embodiment are shown in table 1.

Comparative Example 1

[0060] A protective layer comprising existing mortar that had deteriorated was stripped away from a slope face on a foundation by human power and by machine, after which mortar was sprayed on the slope face in the same way as had been done with the existing protective layer in order to form a protective layer comprising mortar, whereby the slope face was repaired.

[0061] The features of the method for slope face improvement according to Comparative Example 1 are shown in table 1.

Comparative Example 2

[0062] The surface of a protective layer comprising existing mortar that had deteriorated was cleaned in order to remove dirt and foreign material etc., after which a polymer cement (commercial name: Bask, produced by Nichimaru Co.) was used to form a secondary protective layer comprising the polymer cement having a thickness of 2000 μm, whereby the slope face was repaired.

[0063] The features of the method for slope face improvement according to Comparative Example 2 are shown in table 1.

Comparative Example 3

[0064] Short fibers comprising steel fibers or organic fibers were disposed on the surface of a protective layer comprising existing mortar that had deteriorated, and mortar was sprayed in the same way as had been done with the existing protective layer from above said short fibers in order to form a protective layer comprising mortar, whereby the slope face was repaired.

[0065] The features of the method for slope face improvement according to Comparative Example 3 are shown in table 1.

		Exemplary Embodiment	Comparative Example 1	Comparative Example 2	Comparative Example 3
	Cost	Low	High	Low	Medium
	Construction time	Low	High	Low	Medium
	Useful life (years)	20	20	20	20
Performance	Crack-following properties	High (1-10 mm)	None	Low (0-0.5 mm)	None
	Salt-blocking properties	High	None	Low	None
	Water-blocking properties	High	Low	Low	Low
	Neutralization-preventing properties	High	None	Low	None
Environment	CO_2 emission amount	Low because small machinery was used	High because of treatment and transportation of waste material from removing existing mortar etc.	Low because small machinery was used	High because of large machinery used
	Noise	Low	High	Low	High
	Road restrictions	Small-scale	Large-scale traffic restrictions because of heavy machinery used	Small-scale	Large-scale traffic restrictions because of heavy machinery used
Construction/ Management	Management	Few types of work	Many types of work	Few types of work	Many types of work
	Construction period	Short	Long	Short	Long
	Ease of construction	Simple	Complex	Simple	Complex
	Ease of construction (winter season)	Possible	Difficult	Difficult	Difficult
	Construction restrictions	Small	Large	Small	Medium

[0066] It is clear from table 1 that the lifespan-extending layer formed by means of the method for slope face improvement according to the exemplary embodiment on the surface of the protective layer comprising existing mortar that had deteriorated was superior in terms of crack-following properties, salt-blocking properties, water-blocking properties and neutralization-preventing properties in comparison with the protective layers formed by means of the slope face improvement methods according to Comparative Examples 1-3 on the surface of protective layers comprising existing mortar that had deteriorated. Furthermore, the method for slope face improvement according to the exemplary embodiment not only made it possible to repair the slope face in a shorter construction period and at a lower cost than in the case of the methods for slope face improvement according to Comparative Examples 1-3, the method according to the exemplary embodiment was also clearly superior from an environmental perspective in terms of lower carbon dioxide emissions and less noise etc.

FIELD OF INDUSTRIAL APPLICATION

[0067] It is possible to improve safety and maintenance properties by suppressing degradation of a protective layer on a cliff face or slope face etc.

KEY TO SYMBOLS

[0068] **1** . . . Foundation

[0069] **1***a* . . . Slope face

[0070] **2** . . . Protective layer

[0071] **3** . . . Lifespan-extending layer

[0072] **4** . . . Primer layer

[0073] **5** . . . Topcoat layer

[0074] **6** . . . Different-colored region

[0075] **11** . . . Road

1. A method for slope face improvement, in which a lifespan-extending layer is layered on a surface of a protective layer comprising mortar or concrete sprayed on a slope face, whereby penetration of rainwater from cracks that form in the protective layer is prevented, degradation of the protective layer is restricted, and detachment of mortar pieces or concrete pieces from the protective layer is prevented,

wherein a coating layer having crack-following properties of 0.8 mm or greater, salt-blocking properties and neutralization-preventing properties is formed as the lifespan-extending layer.

2. The method for slope face improvement as claimed in claim **1**, wherein the coating layer comprises a polymer compound.

3. The method for slope face improvement as claimed in claim **1**, wherein a primer layer is formed between the protective layer and the lifespan-extending layer.

4. The method for slope face improvement as claimed in claim **1**, wherein a topcoat layer is formed on the lifespan-extending layer.

5. The method for slope face improvement as claimed in claim **2**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

6. The method for slope face improvement as claimed in claim **2**, wherein a primer layer is formed between the protective layer and the lifespan-extending layer.

7. The method for slope face improvement as claimed in claim **2**, wherein a topcoat layer is formed on the lifespan-extending layer.

8. The method for slope face improvement as claimed in claim **3**, wherein a topcoat layer is formed on the lifespan-extending layer.

9. The method for slope face improvement as claimed in claim **6**, wherein a topcoat layer is formed on the lifespan-extending layer.

10. The method for slope face improvement as claimed in claim **3**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

11. The method for slope face improvement as claimed in claim **6**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

12. The method for slope face improvement as claimed in claim **4**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

13. The method for slope face improvement as claimed in claim **7**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

14. The method for slope face improvement as claimed in claim **8**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

15. The method for slope face improvement as claimed in claim **9**, wherein the polymer compound is at least one selected from the group consisting of: polyurethane resin, polyurea resin, epoxy resin and acrylic resin.

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