

DESCRIPTION

COAT FOR PREVENTING CONCRETE EXFOLIATION AND METHOD OF FORMING
COAT FOR PREVENTING CONCRETE EXFOLIATION

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TECHNICAL FIELD

The present invention relates to a coat for preventing concrete exfoliation and a method of forming a coat for preventing concrete exfoliation.

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BACKGROUND ART

It is known that concrete is deteriorated and exfoliated by brine damage, neutralization, an alkali-aggregate reaction and frost damage. In concrete structures such as roads, elevated structures of railroads, tunnels or buildings, it is pointed out that due to this developing deterioration, there is the risk of falling of delaminated concrete pieces by stresses or repeated vibrations due to the passage of automobiles or railcars. Some concrete structures are provided with a coating layer with vinylon mesh or the like in order to prevent such a delamination of the concrete pieces. However, there was a problem that many process steps were required in order to form this coated layer.

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On the other hand, as described in, for example, Japanese Kokai Publication No. 2004-60197, there is an approach in which a film layer, consisting of one or more layers including a resin coat of which tensile strength and tensile elongation are specified, is formed on the surface of the concrete structures. However, since a coated layer is consisted of a single resin layer, a range in which it was possible to attain compatibility between the displacement and the strength of the coated layer was narrow, and it was difficult to realize the compatibility between the displacement and the strength at a high level. And, since the film layer obtained by this method is consisted of resin, it had insufficient properties from the viewpoint of reinforcing concrete bodies though it had the adequate ability

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to follow the displacement of concrete such as crevices or cracks of concrete.

And, as a method of forming a reinforcing layer for protecting the surface of concrete, there is described a method of forming a reinforcing layer consisting of a glass fiber sheet and a thermosetting resin for impregnation in, for example, Japanese Kokai Publication No. 2003-213624.

However, the coated layer obtained by this method had the inadequate ability to follow the displacement of concrete though it had sufficient properties from the viewpoint of reinforcing concrete bodies.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a coat for preventing concrete exfoliation, which has the high ability to follow the displacement of a substrate and can secure adequate function of preventing the concrete exfoliation, and a method of forming a coat for preventing concrete exfoliation.

The present invention relates to a coat for preventing concrete exfoliation comprising a displacement layer provided on a concrete substrate and a reinforcing layer provided on the displacement layer, wherein (1) the displacement layer has cohesion or adhesion to the substrate of 0.1 to 50 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute, (2) the reinforcing layer has tensile strength of 5 MPa or larger and percentage elongation of 3% or higher at a temperature of 23°C and 65% in humidity and at a tensile speed of 10 mm/minute, and (3) the coat for preventing concrete exfoliation has a maximum displacement of 10 mm or larger and a maximum load of 0.3 kN or larger in a punching shear test of concrete of 100 mm in diameter in environments of a temperature of 23°C and 65% in humidity.

The displacement layer may be obtained from, for example, a curable resin composition for a displacement layer, and further the reinforcing layer may be obtained from, for example, a curable

resin composition for a reinforcing layer.

And, the reinforcing layer may be obtained from a curable resin composition for a reinforcing layer and a high tensile strength fiber sheet.

5 Further, the high tensile strength fiber sheet may comprise resin fiber.

Herein, the curable resin composition for a displacement layer may be identical to the curable resin composition for a reinforcing layer.

10 The above-mentioned coat for preventing concrete exfoliation may comprise a protective layer.

And, the present invention relates to a method of forming a coat for preventing concrete exfoliation comprising the steps of (a) forming a displacement layer on a concrete substrate and
15 (b) forming a reinforcing layer on a displacement layer obtained by the step (a), wherein (1) the displacement layer has cohesion or adhesion to the substrate of 0.1 to 50 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute, (2) the reinforcing layer has tensile strength of 5 MPa or larger
20 and percentage elongation of 3% or higher at a temperature of 23°C and 65% in humidity and at a tensile speed of 10 mm/minute, and (3) the coat for preventing concrete exfoliation has a maximum displacement of 10 mm or larger and a maximum load of 0.3 kN or larger in a punching shear test of concrete of 100 mm in diameter
25 in environments of a temperature of 23°C and 65% in humidity.

Further, the present invention relates to a method of repairing concrete,

in which a coat for preventing concrete exfoliation undergoing displacement on a concrete substrate is removed, the
30 concrete is repaired, and then the method of forming a coat for preventing concrete exfoliation described above is performed.

Since the coat for preventing concrete exfoliation of the present invention comprises the above-mentioned two layers, this coat just undergoes displacement and the break of the coat does
35 not take place even if the delamination of concrete pieces due

to the degradation in a substrate takes place. The fact that the coat for preventing concrete exfoliation has the displacement layer and the reinforcing layer which share functions and have prescribed physical properties, respectively, enables this.

5 That is, in the present invention, when the exfoliation of concrete pieces takes place, the displacement layer bears a function of moderately spreading the stress to the film, which is produced by the exfoliation, by the delamination or the break of cohesion within the coat, and the reinforcing layer bears
10 a function of withstanding the weight of the delaminated concrete to prevent the coat from breaking due to the rapidly developing displacement of the coat.

Therefore, the delamination of the substrate could be visually identified by the displacement of the coat and the
15 repairs of a concrete substrate could be properly made.

And, when the high tensile strength fiber sheet is included as a reinforcing layer, it becomes possible to reinforce lightly a concrete substrate by attaining compatibility between a high displacement and a property withstanding the weight of the
20 delaminated concrete. Particularly, when a fiber sheet treated or produced in a temperature range above an ambient temperature is employed, it could be readily realized to secure these functions even in environments of low temperature and high temperature.

25 Coat for preventing concrete exfoliation

A coat for preventing concrete exfoliation of the present invention comprises a displacement layer provided on a concrete substrate and a reinforcing layer provided on the displacement layer. The concrete substrate can include, for example,
30 substances consisting of cements, limes or plaster.

The above-mentioned displacement layer follows the above displacement of a substrate, and it shares a function of moderately spreading the stress produced by the displacement by allowing the break of cohesion within the displacement layer,
35 the delamination between the above displacement layer and the

above substrate, and/or the delamination between the above displacement layer and the above reinforcing layer to proceed mildly so that the stress does not concentrate to prevent the falling of concrete pieces due to the exfoliation and to protect the coat for preventing concrete exfoliation from the break. As with the prior art, when the strength of the coat is developed by a hard film such as a glass fiber sheet, it is dangerous because while an external coat displacement is small and hard to recognize, the coat cannot withstand the displacement and the rapid break of the coat takes place. In the coat for preventing concrete exfoliation of the present invention, the displacement of the coat takes place largely and can prevent the rapid break of the coat.

The above displacement layer has cohesion or adhesion to the above substrate of 0.1 to 50 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute. When the above cohesion or adhesion to the above substrate is smaller than 0.1 N/mm, the break of cohesion within the displacement layer, the delamination of the displacement layer from the substrate, and/or the delamination of the displacement layer from the reinforcing layer takes place even for a small displacement of the above substrate, and therefore it becomes difficult to identify a location requiring repair in repairing the substrate. And, when the cohesion or adhesion to the above substrate is larger than 50 N/mm, it becomes substantially difficult to follow the displacement of a substrate. It is preferred to be 0.5 to 30 N/mm.

The above-mentioned cohesion or adhesion can be measured specifically by conducting a 90 degree peel strength test referred to as a peeling test on a substrate on which a coat for preventing concrete exfoliation has been formed according to JIS K 6854-1, and they can be measured with, for example, a tensile testing machine.

Whether the value obtained by the above-mentioned measurement is the cohesion or the adhesion is determined by

checking a delaminated interface of the sample after the completion of measurement. That is, when the delamination results from the break of cohesion within the displacement layer, it is determined that the obtained value represents the cohesion, and when the delamination takes place at an interface between any laminates such as an interface between a substrate and a coat for preventing concrete exfoliation, it is determined that the obtained value represents the adhesion. That is, in the above displacement layer, the value of peel strength obtained by the above 90 degree peel strength test falls within the range described above.

The value obtained by the above measurement preferably represents the cohesion. When the obtained value represents the adhesion, a delaminated interface exists between laminates, and therefore when the coat for preventing concrete exfoliation is actually formed, water may penetrate into this portion between laminates due to dew condensation or the like and the degradation speed of the coat for preventing concrete exfoliation or the concrete substrate may increase.

Such a displacement layer is not particularly limited and can include, for example, so-called mortar consisting of cement components and fine aggregate components; cement base film obtained from cement base compositions such as polymer cement mortar formed by adding an organic resin such as emulsion and styrene-butadiene rubber emulsion to the above mortar; and a cured resin film obtained from a curable resin composition for a displacement layer. The above displacement layer is preferably obtained from the curable resin composition for a displacement layer from the viewpoint of the ease of controlling the film physical properties of the above displacement layer.

The above curable resin composition for a displacement layer is not particularly limited and can include a resin composition in which curing proceeds at room temperature and a resin composition in which curing proceeds by heating, but from the situation where the resin composition is applied, the

resin composition in which curing proceeds at room temperature is preferred. The above resin composition in which curing proceeds at room temperature can include, for example, a resin composition cured by being left standing to dry, a resin
 5 composition cured by moisture and a resin composition cured by light irradiation.

The above-mentioned resin composition in which curing proceeds at room temperature is not particularly limited, and an urethane resin composition including a hydroxyl
 10 group-containing resin and an isocyanate group-containing curing agent, an urea resin composition including an amino group-containing resin and a isocyanate group-containing curing agent, and an epoxy resin composition including an epoxy
 15 group-containing resin and an amino group-containing curing agent are preferred from the viewpoint of the chemical resistance of a coat for preventing concrete exfoliation to be obtained, or an unsaturated resin composition including an unsaturated
 20 group-containing resin and an oxidative polymerization accelerator, which is cured by being left standing and dried, and a UV-cured vinyl ester resin composition are preferred. In addition, the above curable resin composition for a displacement layer may assume various forms such as a water-borne type, an organic solvent-borne type and a solventless type.

The above-mentioned hydroxyl group-containing resin can
 25 include, for example, acrylic resins, polyester resins, polyether resins, various fats and oils, and polybutadiene resins, which have a hydroxyl group as a curable functional group. The above-mentioned amino group-containing resin can include, for example, aliphatic polyamines, aromatic polyamines, alicyclic
 30 polyamines and modified compounds thereof, which have an amino group as a curable functional group. The above-mentioned epoxy group-containing resin can include, for example, epoxy resins of a glycidyl ether type, a glycidyl ester type and another glycidyl type, alicyclic epoxy resins, and further compounds
 35 obtained by oil modifying or urethane modifying these resins,

which have an epoxy group as a curable functional group. The above-mentioned unsaturated group-containing resin can include, for example, acrylic resins, polyester resins and polyether resins, which have an unsaturated group as a curable functional group.

And, the above-mentioned isocyanate group-containing curing agent can include, for example, monomer, dimer and trimer such as aromatic polyisocyanates, aliphatic polyisocyanates and alicyclic polyisocyanates, and compounds obtained by modifying these isocyanate compounds through a chain extension reaction by diols such as polypropylene glycol. The above-mentioned amino group-containing curing agent can include amino group-containing resins having a relatively small molecular weight among compounds described in the above description of amino group-containing resins.

And, the above-mentioned oxidative polymerization accelerator can include, for example, transition metal compounds such as cobalt compounds.

The above curable resin composition for a displacement layer may further contain pigment. When the above curable resin composition for a displacement layer contains the above-mentioned pigment, its pigment volume concentration is, for example, 5 to 30%. The above pigment is not particularly limited and can include, for example, coloring pigments like inorganic pigments such as chrome yellow, yellow iron oxide, iron oxide, carbon black, titanium dioxide and the like, and organic pigments such as azo chelate pigment, insoluble azo pigment, condensed azo pigment, phthalocyanine pigment, indigo pigment, perynone pigment, perylene pigment, dioxane pigment, quinacridone pigment, isoindolinone pigment, metal complex pigment and the like, and extender pigments such as calcium carbonate, precipitated barium sulfate, clay, talc and the like.

Further, the above curable resin composition for a displacement layer may contain other resins, an organic solvent, a defoaming agent, a thickening agent, a surface control agent,

a plasticizer, an ultraviolet absorber, and a light stabilizer, used in general coating composition areas. Further, if satisfying the above-mentioned conditions, putty and under coating composition, which are well known to those skilled in the art, may be used as the above curable resin composition for a displacement layer.

The above displacement layer preferably has tensile strength of 1 MPa or larger and percentage elongation of 10% or higher at a temperature of 23°C and 65% in humidity and at a tensile speed of 10 mm/minute. When the above tensile strength is smaller than 1 MPa, a coat for preventing concrete exfoliation to be finally obtained will not be tough and it may be impossible to attain a sufficient function of preventing the exfoliation. An upper limit of the tensile strength is not particularly limited but it is substantially 50 MPa. When the tensile strength is larger than 50 MPa, the above range of the percentage elongation may not be satisfied. The tensile strength is more preferably 1 to 30 MPa. And, when the percentage elongation is lower than 10%, a coat for preventing concrete exfoliation to be obtained will be hard and an adequate displacement cannot be secured, and therefore it may be impossible to attain a sufficient function of preventing the exfoliation. An upper limit of the percentage elongation is not particularly limited but it is substantially 1000%. When the percentage elongation is higher than 1000%, the above range of the tensile strength may not be satisfied. The percentage elongation is more preferably 10 to 700%. In addition, the above tensile strength and percentage elongation can be measured with a tensile testing machine such as Autograph AG-100KNE (manufactured by SHIMADZU CORPORATION) and Tensiron (manufactured by Toyo Baldwin CO., LTD.), which are well known to those skilled in the art, using a free film of a single-layer film of the above displacement layer as a sample. When the above tensile testing machines are used for measurement, the above tensile strength and percentage elongation are measured under the conditions of a temperature of 23°C, 65% in humidity and

at a tensile speed of 10 mm/minute.

The tensile strength and percentage elongation of the above displacement layer can be adjusted to be within the preferred range mentioned above by a selection of the curable resin composition for a displacement layer to be used.

It is considered that the above tensile strength and percentage elongation relates closely to each other. Generally, when the tensile strength is high, the percentage elongation becomes small and the film has hard and brittle properties. On the contrary, when the percentage elongation is large, the tensile strength becomes small and the film has soft and weak properties. The above tensile strength and percentage elongation can be controlled by the glass transition point (T_g) and the molecular weight between crosslinked portions of the film, and by the pigment volume concentration (PVC) of the film if the film contains pigment. That is, when the above T_g of the film is enhanced, generally, the tensile strength becomes large and the percentage elongation becomes small. When the above molecular weight between crosslinked portions is increased, generally, the percentage elongation becomes large and the tensile strength becomes small. And, when the pigment volume concentration is increased, the tensile strength is reduced and the percentage elongation becomes small. Based on this concept, the constituents of the above curable resin composition for a displacement layer can be changed.

T_g of the above single-layer film of a displacement layer can be controlled by T_g and the formulation and an amount of a curable functional group of a resin and a curing agent, composing a curable resin composition for a displacement layer to be used. On the other hand, the molecular weight between crosslinked portions can be controlled by the molecular weight of a resin and a curing agent and the concentration of a curable functional group in a resin and a curing agent. For example, as a method of controlling T_g from an aspect of resin, a method of controlling T_g by selecting the species of resin is feasible. Generally,

Tg of polyether resin or polybutadiene resin tends to be low and Tg of acrylic resin or polyester resin is easy to control by Tg of a raw material.

5 As a method of controlling Tg from an aspect of a curing agent, for example when the curing agent is one containing an isocyanate group, it is possible to attain a resin composition having high Tg by selecting a curing agent having high Tg like an aromatic curing agent or an associated substance such as isocyanurate, and by using flexible diol for a chain extension
10 reaction of diisocyanate. And, an amount and a concentration of a curable functional group, and a molecular weight can be controlled by a method well known to those skilled in the art. However, since Tg and an amount of a curable functional group of a resin and a curing agent do not necessarily relates uniquely
15 to the tensile strength and the percentage elongation of a film, it is preferred to select an objective curable resin composition for a displacement layer by trial-and-error methods.

Tg of a resin composing a curable resin composition for a displacement layer for forming the above displacement layer
20 is preferably -60 to -10°C . In addition, Tg can be derived from the composition of monomers composing a resin.

In the case of the above-mentioned Tg, in order to realize the specified cohesion or adhesion of the present invention, for example, the molecular weight between crosslinked portions
25 may be controlled within a range of 500 to 10000.

In modifying the constitution of the above curable resin composition for a displacement layer, respective components may be produced on one's own or selected from commercially available material.

30 The above reinforcing layer bears a function of withstanding the weight of the delaminated concrete to protect the coat for preventing concrete exfoliation from the break by its toughness. The above reinforcing layer has tensile strength of 5 MPa or larger and percentage elongation of 3% or higher
35 at a temperature of 23°C and 65% in humidity and at a tensile

speed of 10 mm/minute. When the above tensile strength is smaller than 5 MPa, a coat for preventing concrete exfoliation to be finally obtained will not be tough and a sufficient function of preventing the exfoliation cannot be attained. An upper limit of the tensile strength is not particularly limited but it is substantially 50 MPa. When the tensile strength is larger than 50 MPa, the above range of the percentage elongation may not be satisfied. The tensile strength is more preferably 5 to 30 MPa. And, when the percentage elongation is lower than 3%, a coat for preventing concrete exfoliation to be obtained will be hard and an adequate displacement cannot be secured, and therefore a sufficient function of preventing the exfoliation cannot be attained. An upper limit of the percentage elongation is not particularly limited but it is substantially 1000%. When the percentage elongation is higher than 1000%, the above range of the tensile strength may not be satisfied. The percentage elongation is more preferably 3 to 700%. In addition, the above tensile strength and percentage elongation can be obtained specifically by the same method of measuring the tensile strength and the percentage elongation as in the above description of the displacement layer.

Such a reinforcing layer can include a layer obtained from a curable resin composition for a reinforcing layer. The above-mentioned curable resin composition for a reinforcing layer can include, specifically, the curable resin composition for a displacement layer described in the above description of the displacement layer, and its species may be identical to that of the above curable resin composition for a displacement layer. Even if the coat for preventing concrete exfoliation of the present invention consists of the identical curable resin composition satisfying both the condition of the displacement layer and the condition of the reinforcing layer, it does not consist of one layer which is thick, and it is important that it comprises two layers of the displacement layer and the reinforcing layer.

In the case of the resin used for the above curable resin composition for a reinforcing layer, in order to obtain the above tensile strength and the above percentage elongation, for example, it is good to control T_g within a range of -50 to 0°C and the molecular weight between crosslinked portions within a range of 500 to 10000.

Further, the above curable resin composition for a reinforcing layer may include a cellulose derivative such as chopped strands.

And, the above reinforcing layer may be obtained from a curable resin composition for a reinforcing layer and a reinforcing material. By including the above reinforcing material, the toughness of a coat for preventing concrete exfoliation to be obtained increases and an effect of reinforcing lightly a concrete substrate can be enhanced. The above reinforcing material is not particularly limited and can include, for example, glass mat, a fiber sheet and the like.

Herein, the above reinforcing material is preferably a high tensile strength fiber sheet. By including the above-mentioned high tensile strength fiber sheet, the above reinforcing layer further becomes tough and an effect of reinforcing lightly a concrete substrate can be further enhanced, and it is possible to secure an extremely high function of preventing delamination even in environments of low temperature and high temperature.

The above high tensile strength fiber sheet preferably has tensile strength of 5 N/mm or larger and tensile elongation at break of 3% or higher at a temperature of 23°C and 65% in humidity. When the above high tensile strength fiber sheet is a sheet of which the above tensile strength is less than 5 N/mm, the above effect of reinforcing the substrate may be insufficient. And, an upper limit of the tensile strength is not particularly limited but it is substantially 100 N/mm. When the tensile strength is larger than 100 N/mm, it is economically disadvantageous and the above condition on the tensile elongation

at break may not be satisfied. The tensile strength is more preferably 10 to 90 N/mm. And, when the above high tensile strength fiber sheet is a sheet of which the above tensile elongation at break is lower than 3%, the ability of the sheet to follow the displacement of the above substrate may be deteriorated. An upper limit of the tensile elongation at break is not particularly limited but it is substantially 500% or lower. When the tensile elongation at break is higher than 500%, the effect of reinforcing lightly the substrate may be insufficient.

The tensile elongation at break is more preferably 4 to 100%. In addition, the above-mentioned tensile strength and tensile elongation at break can be obtained by the same method of measuring the tensile strength and the percentage elongation as in the above description of the displacement layer, using a fiber sheet singly.

A form of such a high tensile strength fiber sheet is not particularly limited and can include, for example, plain weave, triaxial mesh, and nonwoven fabric. And, a material of the above high tensile strength fiber sheet is not particularly limited and can include materials including carbon fiber, including metal fiber, including glass fiber, and including resin fiber, but it is economically preferred that this material comprises resin fiber which can realize the compatibility between the above-mentioned tensile strength and tensile elongation at break at a high level. The above-mentioned resin fiber is not particularly limited and can include nylon fiber, fiber including aramid fiber, acrylic fiber, polyester fiber, and vinylon fiber, and it is preferably fiber treated or produced at a temperature of 100°C or higher. And, in order to improve the adhesion property to the above curable resin composition, the above resin fiber preferably has a hydroxyl group. The integration with resin can improve punching displacement and strength. As such a high tensile strength fiber sheet which is commercially available, for example, vinylon cloth UV #130, UV #200, and TRINEO TSS-1810-Y, vinylon triaxial mesh (every one produced by UNITIKA

LTD.) can be exemplified.

Each of the above displacement layer and the above reinforcing layer, which constitute the coat for preventing concrete exfoliation of the present invention may comprise not only one layer but also two or more layers as long as it satisfies the conditions as the above displacement layer or the above reinforcing layer. By comprising two or more layers, a coat thickness can be thickened, and an appearance and performance provided for each layer can be improved.

The coat for preventing concrete exfoliation of the present invention has a maximum displacement of 10 mm or larger and a maximum load of 0.3 kN or larger in a punching shear test of concrete of 100 mm in diameter in environments of a temperature of 23°C and 65% in humidity. In the case of a coat to break by a displacement of less than 10 mm, it is difficult to withstand the displacement of a substrate. And, when the above-mentioned maximum load is less than 0.3 kN, the coat for preventing concrete exfoliation cannot withstand the small displacement of the above substrate and may readily break, resulting in the exfoliation of concrete in some cases. The maximum load is preferably 1.5 kN or larger, and an upper limit thereof is not particularly limited but it is preferably substantially 10 kN. In addition, the above punching shear test of concrete is performed according to the following procedures.

(i) A center portion of a concrete plate of a U-shaped lid, having the designation of 1st class 300 (400 mm in length by 600 mm in width by 60 mm in thickness), specified in JIS A 5372: 2000 (Precast reinforced concrete products), which has been cured in environments of a temperature of 23°C and 65% in humidity, is vertically drilled in the form of 100 mm in diameter with a bottom of 5 mm in thickness left with a core cutter for concrete. In addition, this drilling is performed from the opposite side of a working face. Further, surface treatment is applied to the working face with a sander cleaning.

(ii) Next, based on a working specification, the coat for

preventing concrete exfoliation of the present invention was formed to prepare a test body. In addition, an area to be provided with the coat for preventing concrete exfoliation is a center portion of 400 mm x 400 mm of the U-shaped lid.

5 (iii) The obtained test plate is placed in environments of a temperature of 23°C and 65% in humidity, and a tensile tester of a first class or higher which is specified in JIS B 7733 paragraph 6 is used as a tester of a punching shear test, and the test plate is secured on a H steel with the side of a coat
10 for preventing concrete exfoliation down, and a maximum displacement and a maximum load are measured by loading from above. Loading speeds are 1 mm/minute and 5 mm/minute before and after an initial peak appears, respectively.

Incidentally, the above tensile testing machine is not
15 particularly limited and can include, for example, Autograph AG (manufactured by SHIMADZU CORPORATION).

It is preferred to combine the displacement layer with the reinforcing layer arbitrarily in such a way that the above coat for preventing concrete exfoliation has the above-mentioned
20 properties.

The coat for preventing concrete exfoliation of the present invention may include a protective layer having functions such as corrosion resistance, fire resistance, prevention of degradation by ultraviolet light and enhancement of an aspect
25 on the reinforcing layer. The above-mentioned protective layer can develop, specifically, the above-mentioned functions, and it is obtained from a protective coating composition. Such a protective coating composition is not particularly limited and can include, for example, an intermediate coating composition
30 or a top coating composition, which is well known to those skilled in the art, such as acrylic resin coating composition, epoxy resin coating composition, urethane resin coating composition and fluorocarbon resin coating composition. Further, when the above substrate is a concrete base substrate, it is preferred
35 to use a coating composition having elasticity referred to as

a flexible type so that it can follow the displacement of the substrate.

Method of forming coat for preventing concrete exfoliation

5 The method of forming a coat for preventing concrete exfoliation of the present invention has the step (a) of forming a displacement layer on a concrete substrate. The above-mentioned displacement layer has cohesion or adhesion to the above substrate of 0.1 to 50 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute. Herein,
10 the above concrete substrate can include, specifically, substances described in the above description of the coat for preventing concrete exfoliation.

The above displacement layer consists of, for example, the cement base film or the cured resin film described in the
15 above description of the coat for preventing concrete exfoliation. Because of ease of adjustment of film properties, the above displacement layer is preferably the cured resin film, and preferably a layer obtained from a curable resin composition for a displacement layer described in the description of the
20 displacement layer of the coat for preventing concrete exfoliation described above.

The above step (a) is, specifically, a step of applying the mortar base composition or curable resin composition for a displacement layer onto the above concrete substrate. A method
25 of the above application is not particularly limited and can include methods well known to those skilled in the art such as brush application, spray application, roller application, trowel application, paddle application and the like. Specifically, this method can be appropriately selected in
30 accordance with species of the above mortar base composition and the above curable resin composition for a displacement layer. A film thickness of a displacement layer thus obtained is not particularly limited and it can be appropriately selected in accordance with species of the above mortar base composition
35 and the above curable resin composition for a displacement layer,

and for example, it is 0.5 to 5 mm in the case of the mortar base composition and 30 to 1000 μm in the case of the curable resin composition for a displacement layer.

5 Herein, the above step (a) may be applied directly onto the above concrete substrate or may be performed after smoothing the bumps and dips of a concrete substrate with cross section patching mortar.

10 The method of forming a coat for preventing concrete exfoliation of the present invention further has the step (b) of forming a reinforcing layer on a displacement layer obtained by the above-mentioned step (a). The above-mentioned reinforcing layer has tensile strength of 5 MPa or larger and percentage elongation of 3% or higher at a temperature of 23°C and 65% in humidity and at a tensile speed of 10 mm/minute. The
15 above reinforcing layer is obtained from, for example, the curable resin composition for a reinforcing layer described in the above description of the coat for preventing concrete exfoliation.

20 The above step (b) is, specifically, a step of applying the above-mentioned curable resin composition for a reinforcing layer onto the displacement layer. A method of the above application is not particularly limited and can include methods described in the above description of the step (a). A film thickness of the application is not particularly limited, and
25 it is, for example, 0.5 to 2 mm.

 And, when the above reinforcing layer includes the reinforcing material described in the above description of the coat for preventing concrete exfoliation, the above step (b) may comprise a step (b-1) of sticking a reinforcing material
30 and a step (b-2) of applying the above-mentioned curable resin composition for a reinforcing layer. In this case, by including the above reinforcing material in a reinforcing layer to be obtained, the toughness of the reinforcing layer can increase and the above effect of reinforcing lightly a concrete substrate
35 can be further enhanced.

The above reinforcing material is further preferably a high tensile strength fiber sheet from the viewpoint of securing extremely high function of preventing the concrete exfoliation even in environments of low temperature and high temperature.

- 5 The above high tensile strength fiber sheet can include, specifically, substances described in the above description of the coat for preventing concrete exfoliation.

- 10 The above step (b-1) is, for example, a step of applying an adhesive to a whole surface or a required area on a displacement layer obtained by the above step (a) and then sticking the above reinforcing material. The above-mentioned adhesive is not particularly limited and can include adhesives well known to those skilled in the art and in addition the curable resin composition for a reinforcing layer described in the above description of the coat for preventing concrete exfoliation.
- 15 In the above step (b-1), a method of applying the above adhesive is not particularly limited and can include, specifically, methods described in the above description of the step (a). A film thickness of the above application is not particularly
- 20 limited, and it may be at a level of thickness at which the above reinforcing material can be stuck before completing the following step (b-2). A method of sticking the above reinforcing material is not particularly limited and can include methods well known to those skilled in the art.

- 25 The above step (b-2) is, for example, a step of applying the above curable resin composition for a reinforcing layer over the above stuck reinforcing material in such a way that the curable resin composition for a reinforcing layer is integrated with the reinforcing material after the above step (b-1). By thus
- 30 constituting, it is possible to obtain a composite film in which the curable resin composition for a reinforcing layer is integrated with the reinforcing material and to strengthen the reinforcing layer more.

- 35 In addition, the adhesive in the above step (b-1) and the curable resin composition for a reinforcing layer in the above

step (b-2) may be identical to the curable resin composition for a displacement layer in the above step (a). In the above step (b-2), a method of applying the above curable resin composition for a reinforcing layer is not particularly limited and can include, specifically, methods described in the above description of the step (a). A film thickness of the above application is not particularly limited and preferably up to such a thickness that the above reinforcing material is embedded in the above curable resin composition for a reinforcing layer from the viewpoint of the toughness of the film to be obtained, and a film thickness as the above composite film is, for example, 5 mm or less.

Herein, the displacement layer obtained in the above step (a) and the reinforcing layer obtained in the above step (b) are not limited to the case where only one layer is formed, and these two layers include the case where two or more layers are formed, respectively, as long as each of them satisfies the conditions of the above respective layers, respectively. By consisting of two or more layers, a coat thickness can be thickened, and an appearance and performance provided for each layer can be improved.

Further, a interval time of processing between each step in the above step (a) or (b) and a step just past is preferably on the order of such time that the applied surface is dried to such an extent that the applied surface does not get fingerprints on it when touching the applied surface with a finger from the viewpoint of adhesion.

A coat for preventing concrete exfoliation obtained in the method of forming a coat for preventing concrete exfoliation of the present invention has cohesion or adhesion to the above substrate of 0.1 to 100 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute. Specifically, substances described in the above description of the coat for preventing concrete exfoliation can be given.

The method of forming a coat for preventing concrete

exfoliation of the present invention may further comprise the step (c) of applying a protective coating composition to form a protective layer. The above-mentioned protective coating composition is not particularly limited and can include the same substances as described in the above description of the coat for preventing concrete exfoliation. And, a method of applying the coating composition described above is not particularly limited and can include, specifically, a procedure described in the above step (a). A dried film thickness of the protective film thus prepared is not particularly limited and is, for example, 30 to 100 μm .

Method of repairing concrete

A method of repairing concrete of the present invention is a method in which a coat for preventing concrete exfoliation undergoing displacement on a concrete substrate is removed, the concrete is repaired, and then the method of forming a coat for preventing concrete exfoliation described above is performed. The above-mentioned concrete substrate can include, specifically, substances described in the above description of the coat for preventing concrete exfoliation. The above-mentioned coat for preventing concrete exfoliation undergoing displacement is not particularly limited and can include the coat for preventing concrete exfoliation described above and in addition a substance formed by sticking a steel sheet, a sheet, a mesh or a glass fiber sheet, which is commonly used, with an adhesive, and further a substance formed by applying an intermediate coating composition and/or a top coating composition thereon.

The above-mentioned displacement takes place due to the exfoliation of concrete pieces. The above occurrence of a displacement is identified by visually checking the surface of the above coat for preventing concrete exfoliation. Herein, the displacement refers to the magnitude of vertical change relative to a plane of the coat for preventing concrete

exfoliation, and if the magnitude of change is, for example, 10 mm, it is determined that a displacement of 10 mm takes place. The concrete-repairs made on a location where a displacement has taken place is made by a method well known to those skilled in the art, for example, repairing with patching mortar after cutting off a coat for preventing concrete exfoliation of a location where a displacement has been observed.

With respect to the above remedied concrete, after treating the surface of the remedied concrete as required, the method of forming a coat for preventing concrete exfoliation described above is applied to the surface.

Examples

Hereinafter, the present invention will be described in detail by way of specific examples, but the present invention is not limited by the following examples. In addition, "part(s)" refers to "part(s) by weight".

Production Example 1: Preparation of substrate

A center portion of a concrete plate of a U-shaped lid, having the designation of 1st class 300 (400 mm in length by 600 mm in width by 60 mm in thickness), specified in JIS A 5372: 2000 (Precast reinforced concrete products), which has been cured in environments of a temperature of 23°C and 65% in humidity, is vertically drilled in the form of 100 mm in diameter with a bottom of 5 mm in thickness left with a core cutter for concrete.

Further, a surface which has not been drilled was cleaned with a sander to remove a brittle layer on the surface and smooth the surface, and then Tough Guard E-VM Primer (epoxy resin base primer produced by Nippon Paint Co., Ltd.) was applied in such a way that an application rate is 0.2 kg/m² with a brush, and the U-shaped lid provided with a primer was left standing at room temperature for a day to obtain a substrate.

Production Example 2: Preparation of curable resin composition

1

ADEKA RESINEPU-86 (urethane modified epoxy resin produced by Asahi Denka CO., LTD., solid content 100%, liquid at room temperature) 100 parts, 15 parts of TIPACUE R-820 (titanium dioxide produced by ISHIHARA SANGYO KAISHA, LTD.), 40 parts of TALC PK 50 (talc produced by Fuji Talc Ind. Co., Ltd.) and 10 parts of xylene were mixed and kneaded, and then in this, 14 parts of ADEKA HARDENER EH-220 (amino group-containing curing agent produced by Asahi Denka CO., LTD.) was mixed to prepare an epoxy base curable resin composition 1. A PVC of this resin composition was 15%.

Production Example 3: Preparation of curable resin composition 2

POLYHARDNER UD-503 (polyether resin having a hydroxyl group produced by DAI-ICHI KOGYO SEIYAKU CO., LTD., solid content 100%, liquid at room temperature) 30 parts, 15 parts of TIPACUE R-820, 47 parts of TALC PK 50 and 10 parts of xylene were mixed and kneaded, and then in this, 100 parts of POLYFLEX FL-83 (isocyanate group-containing curing agent produced by DAI-ICHI KOGYO SEIYAKU CO., LTD.) was mixed to prepare an urethane base curable resin composition 2. A PVC of this resin composition was 15%.

<Measurement of tensile strength and percentage elongation>

A free film of a single-layer film obtained from this curable resin composition 2 was used, and the physical properties of the film were measured with Autograph AG-100KNE (a tensile testing machine manufactured by SHIMADZU CORPORATION, a temperature of 23°C, 65% in humidity, a tensile speed of 10 mm/minute) according to JIS K 7113-1981, and consequently the tensile strength was 9.3 MPa and the percentage elongation was 350%.

Production Example 4: Preparation of curable resin composition

35 3

An urethane base curable resin composition 3 was prepared by following the same procedure as in Production Example 3 except for changing an amount of TALC PK 50 to be mixed from 47 parts to 11 parts and changing 100parts of POLYFLEX FL-83 into 20 parts of MILLIONATE MTL (isocyanate base curing agent produced by NIPPON POLYURETHANE INDUSTRY CO., LTD.) having a large amount of a curable functional group. In addition, a PVC of this resin composition was 15%.

The physical properties of a free film of a single-layer film obtained from the curable resin composition 3 were measured in the same manner as in Production Example 3, and consequently the tensile strength and the percentage elongation were 16.0 MPa and 52%, respectively.

Example 1

<Measurement of cohesion and adhesion of displacement layer>

To a cement mortar plate of 150 mm x 70 mm x 20 mm prepared according to JIS K 5410, the surface during molding of which had been adequately ground with an abrasive paper P 180 specified in JIS R 6252, Tough Guard E-VM Primer was applied in such a way that an application rate is 0.2 kg/m² with a brush, and the cement mortar plate provided with a primer was left standing at room temperature for 16 hours to obtain a base plate. A craft tape is affixed to a half of the surface of this base plate, and then the curable resin composition 1 obtained in Production Example 2 was applied with a brush in such a way that an application rate as a curable resin composition for a displacement layer is 0.26 kg/m² to form a displacement layer. The resulting displacement layer was left standing for 16 hours, and it was confirmed that the displacement layer was dried to such an extent that the displacement layer does not get fingerprints on it when touching the displacement layer with a finger, and then onto the obtained displacement layer, the curable resin composition 2 obtained in Production Example 3 was applied at an application rate of 1.8 kg/m² as a curable resin composition for a reinforcing

layer with a paddle to form a reinforcing layer. Then, the base plate provided with the reinforcing layer was left standing at 23°C for 7 days to obtain a base plate provided with a coat for preventing concrete exfoliation.

5 Subsequently, the coat for preventing concrete exfoliation on the craft tape, which did not adhere to the base plate, was set into the chuck of Autograph AG (a tensile testing machine manufactured by SHIMADZU CORPORATION), and a 90 degree peel strength test was conducted at a temperature of 23°C and
10 65% in humidity and at a peeling speed of 50 mm/minute according to JIS K 6854-1, and consequently the break of cohesion took place within the displacement layer and the cohesion at this time was 0.6 N/mm.

15 <Measurement of maximum load and maximum displacement by punching shear test of concrete>

Onto the substrate obtained in Production Example 1, the curable resin composition 1 obtained in Production Example 2 was applied at an application rate of 0.26 kg/m² as a curable resin composition for a displacement layer with a paddle in such
20 a way that an coated area is 400 mm x 400 mm to form a displacement layer. The resulting displacement layer was left standing for 16 hours and it was confirmed that the displacement layer was dried to such an extent that the displacement layer does not get fingerprints on it when touching the displacement layer with
25 a finger, and then onto the obtained displacement layer, the curable resin composition 2 obtained in Production Example 3 was applied at an application rate of 1.8 kg/m² as a curable resin composition for a reinforcing layer with a paddle in such
30 a way that an coated area is 400 mm x 400 mm to form a reinforcing layer. Then, the substrate provided with the reinforcing layer was left standing at 23°C for 7 days to obtain a test substrate provided with a coat for preventing concrete exfoliation.

In environments of a temperature of 23°C and 65% in humidity, the obtained test substrate was secured on H steel at a span
35 of 400 mm with the side of a coat for preventing concrete

exfoliation down. Using Autograph AG, a center portion of a drilled cylindrical portion was vertically loaded from above interposing a spherical seat so as to exert a uniform load to measure a maximum load and a maximum displacement. In addition, loading speeds were 1 mm/minute and 5 mm/minute before and after the initial peak appeared, respectively. And, the physical properties of the coat at this time were measured, and consequently the coat had a maximum load of 1.7 kN and a maximum displacement of 50 mm or larger.

10 <Repairability>

A part of the coat for preventing concrete exfoliation of the above test substrate was peeled off with a disk sander to expose a substrate area. By applying the same procedure as in the method of forming a coat for preventing concrete exfoliation in the above measurement of maximum load and maximum displacement by punching shear test of concrete to this exposed area, a coat for preventing concrete exfoliation could be formed again on this exposed area without problems.

20 Example 2

The cohesion and the adhesion of a displacement layer, and the maximum load and the maximum displacement by a punching shear test of concrete were evaluated by following the same procedure as in Example 1 except for using the curable resin composition 3 of Production Example 4 in place of the curable resin composition 2 of Production Example 3 as a curable resin composition for a reinforcing layer. The obtained results are shown together with the results of Example 1 in Table 1.

Further, the repairability was evaluated in the same manner as in Example 1, and consequently a coat for preventing concrete exfoliation could be formed again without problems.

Example 3

<Measurement of cohesion and adhesion of displacement layer>

35 Onto the whole surface of the displacement layer formed

by following the same procedure as in the method described in the measurement of cohesion and adhesion of a displacement layer in Example 1, the curable resin composition 3 obtained in Production Example 4 was applied with a brush in such a way that an application rate is 0.45 kg/m² as an adhesive, and then immediately to this, a vinylon fiber sheet # UV 200 (produced by UNITIKA LTD.), which has tensile strength of 70 N/mm and tensile elongation at break of 14% at a temperature of 23°C and 65% in humidity, was affixed as a high tensile strength fiber sheet. After affixing, the high tensile strength fiber sheet was pressed against the applied curable resin composition 3 with a paddle to make the curable resin composition 3 permeate into the high tensile strength fiber sheet. However, since the high tensile strength fiber sheet could not be adequately covered with the curable resin composition 3, onto this, again, the curable resin composition 3 was applied at an application rate of 0.45 kg/m² as a curable resin composition for a reinforcing layer with a paddle to form a reinforcing layer which is an integrated combination of the curable resin composition and the high tensile strength fiber sheet. Then, the base plate provided with the reinforcing layer was left standing at 23°C for 7 days to obtain a base plate provided with a coat for preventing concrete exfoliation.

Subsequently, the coat for preventing concrete exfoliation on the craft tape, which did not adhere to the base plate, was set into the chuck of Autograph AG (a tensile testing machine manufactured by SHIMADZU CORPORATION), and a 90 degree peel strength test was conducted at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute according to JIS K 6854-1, and consequently the break of cohesion took place within the displacement layer and the cohesion at this time was 0.6 N/mm.

<Measurement of maximum load and maximum displacement by punching shear test of concrete>

Onto the displacement layer formed by following the same

procedure as in the method of forming a coat for preventing concrete exfoliation described in the measurement of maximum load and maximum displacement by punching shear test of concrete in Example 1, the curable resin composition 3 obtained in
5 Production Example 4 was applied with a paddle in such a way that an application rate is 0.45 kg/m^2 as an adhesive, and then immediately to this, a vinylon fiber sheet # UV 200 was affixed as a high tensile strength fiber sheet. After affixing, the high tensile strength fiber sheet was pressed against the applied
10 curable resin composition 3 with a paddle to make the curable resin composition 3 permeate into the high tensile strength fiber sheet. However, since the high tensile strength fiber sheet could not be adequately covered with the curable resin composition 3, onto this, again, the obtained curable resin
15 composition 3 was applied at an application rate of 0.45 kg/m^2 as a curable resin composition for a reinforcing layer with a paddle in such a way that an coated area is $400 \text{ mm} \times 400 \text{ mm}$ to form a reinforcing layer which is an integrated combination of the curable resin composition and the high tensile strength fiber
20 sheet. Then, the substrate provided with the reinforcing layer was left standing at 23°C for 7 days to obtain a test substrate provided with a coat for preventing concrete exfoliation.

The obtained test substrate was tested in the same manner as in Example 1 to measure the maximum load and the maximum
25 displacement of the coat, and consequently the coat had a maximum load of 4.8 kN and a maximum displacement of 50 mm or larger.

Further, after the test substrate was left standing for 48 hours in a thermostatic chamber of a temperature of 50°C , similarly, the maximum load and the maximum displacement of the
30 coat were measured. Incidentally, as a testing apparatus, a hydraulic press equipped with a pressure sensor and a displacement sensor manufactured by OXJACK Co., Ltd. was used. Measurement was performed while adjusting the hydraulic press so that a loading speed was the same as that in measurement at
35 23°C . Further, also in a thermostatic chamber of -30°C a punching

shear test was similarly performed. The obtained results are shown in Table 1.

<Repairability>

5 The repairability was evaluated in the same manner as in Example 1, and consequently a coat for preventing concrete exfoliation could be formed again without problems.

Example 4

10 The cohesion and the adhesion of a displacement layer, and the maximum load and the maximum displacement by a punching shear test of concrete were evaluated by following the same procedure as in Example 2 except for applying Tough Guard EW Filler (water base epoxy polymer cement produced by Nippon Paint Co., Ltd.) at an application rate of 1.2 kg/m² in place of the
15 curable resin composition 1 of Production Example 2 as a cement base composition for a displacement layer. The obtained results are shown in Table 1.

Further, the repairability was evaluated in the same manner as in Example 1, and consequently a coat for preventing concrete
20 exfoliation could be formed again without problems.

Comparative Example 1

Epikote 828 (bisphenol A epoxy resin produced by Shell Chemical Co., Ltd, solid content 100%) 100 parts, 43 parts of
25 Ganamid 2000 (amine curing agent produced by Henkel Hokusui Corp, solid content 100%) and 52 parts of talc PK 50 were mixed to prepare an epoxy base curable resin composition 5. A PVC of this resin composition was 15%.

A coat for preventing concrete exfoliation was formed to
30 obtain a base plate by following the same procedure as in Example 1 except for using the obtained curable resin composition 5 as a curable resin composition for a displacement layer and a curable resin composition for a reinforcing layer in place of the curable resin composition 1 obtained in Production Example 2 and the
35 curable resin composition 2 obtained in Production Example 3.

Then, the cohesion and the adhesion of the displacement layer, and the maximum load and the maximum displacement by a punching shear test of concrete were evaluated in the same manner as in Example 1. The obtained results are shown in Table 1.

5

Comparative Example 2

A coat for preventing concrete exfoliation was formed to obtain a base plate by following the same procedure as in Example 3 except for using the curable resin composition 5 obtained in
10 Comparative Example 1 as a curable resin composition for a reinforcing layer in place of the curable resin composition 3 obtained in Production Example 4.

Then, the cohesion and the adhesion of the displacement layer, and the maximum load and the maximum displacement by a
15 punching shear test of concrete were evaluated in the same manner as in Example 1. The obtained results are shown in Table 1.

Table 1

		Example					Example	
		1	2	3	4		1	2
Displacement layer	Cohesion or adhesion (N/mm)	0.6	0.6	0.6	3.0		65.0	0.6
	Delaminated portion	Within the layer	Within the layer	Within the layer	Within the layer		Within the layer	Within the layer
	Tensile strength (MPa)	4.0	4.0	4.0	—		40.0	4.0
	Percentage elongation (%)	300	300	300	—		2	300
Reinforcing layer (Resin film)	Tensile strength (MPa)	9.3	16.0	16.0	16.0		40.0	40.0
	Percentage elongation (%)	350	52	52	52		2	2
	Tensile strength (N/mm)	—	—	70	—		—	70
	Tensile elongation at break (%)	—	—	14	—		—	14
Composite coat	23°C	Maximum load (kN)	1.7	2.4	4.8	3.8	2.1	4.1
		Maximum displacement (mm) 1)	50 <	50 <	50 <	28	21	3
	50°C	Maximum load (kN)	—	—	2.8	—	—	—
		Maximum displacement (mm) 1)	—	—	40 <	—	—	—
	-30°C	Maximum load (kN)	—	—	4.2	—	—	—
		Maximum displacement (mm) 1)	—	—	20	—	—	—

1) "50 <" or "40 <" means that the coat did not break even when the displacement was 50 mm or 40 mm.

1) It means that the coat broke at the same time of the break of the substrate in the initial stage of a punching shear test so that the measurement cannot be attained.

As is apparent from the results in Table 1, since the coat for preventing concrete exfoliation of the present invention was composed of the displacement layer having specified cohesion or adhesion to a substrate and the reinforcing layer having specified tensile strength and percentage elongation, the coat for preventing concrete exfoliation had a maximum load of 0.3 kN or larger and a maximum displacement of 10 mm or larger. And, it was found that when the coat for preventing concrete exfoliation of the present invention includes a high tensile strength fiber sheet as a reinforcing layer, it exhibits a good maximum load and a good maximum displacement even in environments of low temperature and high temperature.

Also, it was found that the coat for preventing concrete exfoliation of the present invention has no problems on its repairability.

INDUSTRIAL APPLICABILITY

The coat for preventing concrete exfoliation and the method of forming a coat for preventing concrete exfoliation of the present invention can be suitably employed as a method of preventing concrete exfoliation and a coat for preventing concrete exfoliation in order to prevent the concrete exfoliation for concrete structures such as bridges, elevated bridges and the like.

CLAIMS

1. A coat for preventing concrete exfoliation comprising
a displacement layer provided on a concrete substrate and a
reinforcing layer provided on said displacement layer,
wherein (1) said displacement layer has cohesion or
adhesion to said substrate of 0.1 to 50 N/mm at a temperature
of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute,
(2) said reinforcing layer has tensile strength of 5 MPa
or larger and percentage elongation of 3% or higher at a
temperature of 23°C and 65% in humidity and at a tensile speed
of 10 mm/minute, and
(3) said coat for preventing concrete exfoliation has a
maximum displacement of 10 mm or larger and a maximum load of
0.3 kN or larger in a punching shear test of concrete of 100
mm in diameter in environments of a temperature of 23°C and 65%
in humidity.
2. The coat for preventing concrete exfoliation
according to claim 1,
wherein the displacement layer is obtained from a curable
resin composition for a displacement layer.
3. The coat for preventing concrete exfoliation
according to claim 1 or 2,
wherein the reinforcing layer is obtained from a curable
resin composition for a reinforcing layer.
4. The coat for preventing concrete exfoliation
according to claim 1 or 2,
wherein the reinforcing layer is obtained from a curable
resin composition for a reinforcing layer and a high tensile
strength fiber sheet.
5. The coat for preventing concrete exfoliation

according to claim 4,

wherein the high tensile strength fiber sheet comprises resin fiber.

5 6. The coat for preventing concrete exfoliation according to any one of claims 1 to 5,

wherein the curable resin composition for a displacement layer is identical to the curable resin composition for a reinforcing layer.

10

7. The coat for preventing concrete exfoliation according to any one of claims 1 to 6, comprising a protective layer.

15

8. A method of forming a coat for preventing concrete exfoliation comprising the steps of (a) forming a displacement layer on a concrete substrate and (b) forming a reinforcing layer on a displacement layer obtained by said step (a),

wherein (1) said displacement layer has cohesion or
20 adhesion to said substrate of 0.1 to 50 N/mm at a temperature of 23°C and 65% in humidity and at a peeling speed of 50 mm/minute,

(2) said reinforcing layer has tensile strength of 5 MPa or larger and percentage elongation of 3% or higher at a temperature of 23°C and 65% in humidity and at a tensile speed
25 of 10 mm/minute, and

(3) said coat for preventing concrete exfoliation has a maximum displacement of 10 mm or larger and a maximum load of 0.3 kN or larger in a punching shear test of concrete of 100 mm in diameter in environments of a temperature of 23°C and 65%
30 in humidity.

9. A method of repairing concrete,

in which a coat for preventing concrete exfoliation undergoing displacement on a concrete substrate is removed, the
35 concrete is repaired, and then the method of forming a coat for

preventing concrete exfoliation according to claim 8 is performed.