

TITLE

EVALUATION METHOD FOR CONCRETE COATED WITH
FINISHING MATERIAL

TECHNICAL FIELD

5 [0001] The present disclosure relates to an evaluation method for
evaluating concrete coated with a finishing material.

BACKGROUND

[0002] Conventionally, various evaluation methods for evaluating
concrete are known. Japanese Unexamined Patent Publication No.
10 2003-172681 describes a method for estimating the strength of concrete.
In this strength estimation method, the compressive strength of concrete
is estimated by a nondestructive test method. In this strength
estimation method, the degree of repulsion of the concrete surface is
measured by a concrete test hammer, and the carbonation depth is
15 measured by a carbonation depth tester.

[0003] Japanese Unexamined Patent Publication No. 2005-49235
describes a method for predicting the remaining life of a repaired
concrete frame and a method for calculating a carbonation rate
coefficient used for the prediction. This method calculates a
20 carbonation rate coefficient indicating the relationship between the
exposure time of the concrete frame to the air and the carbonation depth.
In addition, when the surface of a concrete frame that has been
neutralized is repaired by covering with a mortar repair material, the
carbonation rate coefficient of the concrete frame after repair is obtained
25 from the carbonation rate coefficient of the concrete frame that has not
been repaired and the physical property value of the mortar repair

material.

[0004] Japanese Unexamined Patent Publication No. 2011-257212 describes a carbonation depth prediction device for a concrete structure. The carbonation depth prediction device executes a step of setting a statistical mathematical model, a step of loading carbonation depth data, a step of setting a prior distribution of a parameter to be estimate and a likelihood function to apply a Bayesian model, a step of generating a posterior distribution numerically by the Markov chain Monte Carlo (MCMC) method, and a step of estimating the parameter from the posterior distribution.

[0005] Japanese Unexamined Patent Publication No. 2017-9290 describes a carbonation depth measurement method and a carbonation depth measurement seal. The seal has a carbonation region that is neutralized an object and a non-carbonation region that is not neutralized. In this measurement method, the above-mentioned seal is applied to the surface of the cement concrete composition structure, the seal is peeled off after the elapse of a certain period of time, and the length of the carbonation region of the seal is measured. In this manner, the carbonation depth of the cement concrete composition structure is measured.

[0006] Incidentally, in order to suppress the carbonation of concrete, a finishing material may be coated on the concrete. The carbonation suppressing effect of the finishing material is shown in JASS 5's explanatory table 3.6 "Carbonation rates of various finishings using finishing coating materials and paints". However, this explanatory table has room for improvement in terms of accuracy because a larger

numerical value is adopted so as to be evaluated on the safety side. Further, since this explanatory table is not shown for each finishing material, the carbonation suppressing effect of each finishing material cannot be known.

5 [0007] In addition, a method is known in which a finishing material is coated on a concrete test specimen and the carbonation depth after a certain time is measured by an accelerated carbonation test (JIS A 1153). However, this method requires more than 8 months before results are obtained. In addition, this method requires a special device called a
10 carbonation test chamber, and there is a limit to the number of carbonation test chamber that can be prepared. Thus, there is a problem that many tests cannot be carried out at one time. Therefore, there is a problem that the concrete coated with the finishing material cannot be evaluated quickly.

15 [0008] Further, as a method for measuring the permeation amount of gas through the finishing material, a differential pressure method (JIS K 7126-1), a cup method (JIS Z 0208), or a box method for examining the air permeability of a film or the like is known. The “permeation amount” of gas indicates the amount of gas that permeates a certain
20 thing, and includes the amount of gas that permeates per unit time and unit area. In these methods, since a finishing material is coated on a material having high air permeability such as filter paper and measurement is performed, pinholes or uneven coating may occur. Therefore, there is a problem that the result is likely to vary depending
25 on the skill level of a measurer. Therefore, there is a problem that the concrete coated with the finishing material cannot be evaluated with

high accuracy.

[0009] An object of the present disclosure is to provide the evaluation method which can perform the evaluation of the concrete coated with finishing material quickly and with high precision.

5 SUMMARY

[0010] In order to solve the above problems, as a result of the intensive study of the present inventors, it is found that there is a strong correlation between the pigment volume concentration (PVC, also referred to as pigment capacity concentration) of the finishing material and the diffusion coefficient of the gas that permeates the finishing material. Then, it is found that the concrete coated with the finishing material can be evaluated quickly and with high accuracy by obtaining the diffusion coefficient of the gas from the pigment volume concentration of the finishing material. The present disclosure has been made based on such knowledge. That is, an evaluation method according to an embodiment of the present disclosure is an evaluation method for evaluating concrete coated with a finishing material, including: a step of acquiring and storing in advance a relational expression between a diffusion coefficient of gas that permeates a known finishing material and a pigment volume concentration, the relational expression being specified for the known finishing material; a step of acquiring a pigment volume concentration of a finishing material to be evaluated; and a step of calculating a diffusion coefficient of gas that permeates the finishing material to be evaluated from the obtained pigment volume concentration. In the present disclosure, the “known finishing material” indicates a finishing material known at the time of

obtaining the diffusion coefficient of the gas and the pigment volume concentration. The “known finishing material” includes both finishing materials that are already known and new finishing materials that are capable of obtaining a diffusion coefficient of gas and a pigment volume concentration.

[0011] The evaluation method may further include a step of predicting progress of carbonation of the concrete coated with the finishing material to be evaluated, after the step of calculating the diffusion coefficient of the gas. In this case, the progress of carbonation of the concrete coated with the finishing material can be predicted quickly and with high accuracy.

[0012] The evaluation method may further include a step of predicting progress of corrosion of a reinforcing bar embedded in the concrete coated with the finishing material to be evaluated, after the step of calculating the diffusion coefficient of the gas. In this case, the progress of corrosion of the reinforcing bar embedded in the concrete coated with the finishing material can be predicted quickly and with high accuracy.

[0013] According to the present disclosure, it is possible to evaluate the concrete coated with the finishing material quickly and with high accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a graph showing an example of the relationship between a pigment volume concentration (PVC) of a finishing material coated on concrete and an 8-week carbonation depth;

FIG. 2 is a graph showing an example of the relationship

between the PVC and a 26-week carbonation rate coefficient;

FIG. 3 is a graph showing an example of the relationship between a diffusion coefficient of gas (carbon dioxide) that permeates the finishing material and the PVC;

5 FIG. 4 is a graph showing another example of the relationship between the PVC and the diffusion coefficient of gas (carbon dioxide) that permeates the finishing material;

10 FIG. 5 is a block diagram illustrating an example of an evaluation apparatus that executes an evaluation method according to an embodiment; and

FIG. 6 is a flowchart showing an example of each step of the evaluation method according to the embodiment.

DETAILED DESCRIPTION

15 [0015] Hereinafter, embodiments of an evaluation method according to the present disclosure will be described with reference to the drawings. In the drawings, the same or corresponding elements are denoted by the same reference numerals, and redundant description is omitted as appropriate.

20 [0016] In the present disclosure, “finishing material” refers to a material that suppresses passage of gas (carbon dioxide, oxygen, or the like) to concrete in order to suppress carbonation or corrosion of the concrete. The “finishing material” includes, for example, paint, a finishing coating material for construction, a waterproof coating film, and the like. The “carbonation” is a kind of deterioration of concrete caused by
25 carbon dioxide. The “carbonation” indicates that the concrete is changed from alkaline to neutral by intrusion of carbon dioxide into the

concrete. If the concrete is neutralized, there may be a problem that a passive film of a steel material is lost and corrosion resistance is lowered. However, if the “finishing material” has a mechanism for effectively suppressing permeation of carbon dioxide, an effect of suppressing carbonation of concrete can be expected.

[0017] “Pigment Volume Concentration” (PVC) of the finishing material indicates a ratio obtained by dividing the pigment volume of the finishing material by the total volume of pigment and binder, and is also referred to as pigment capacity concentration. The PVC is a value uniquely determined for each finishing material. Hereinafter, the pigment volume concentration may be referred to as PVC. The “pigment” indicates colored pigment or extender pigment contained in paint or the like, and the “binder” indicates a binding material for fixing the pigment. The material of binder includes a synthetic resin such as an acrylic resin or a urethane resin. The “diffusion coefficient” of gas indicates an index of the degree to which gas diffuses in a certain substance.

[0018] The finishing material is coated on the concrete to prevent carbonation or corrosion. In the present embodiment, the concrete coated with the finishing material is evaluated. In the present embodiment, the progress of the carbonation of the concrete when the finishing material is coated on the surface of the concrete is predicted. In the progress prediction of the carbonation, for example, the carbonation depth that progresses in a certain period is predicted, and as a specific example, how many mm of the carbonation progresses in a certain year is predicted. In the present embodiment, attention is paid

to the relationship between the PVC of the finishing material and the diffusion coefficient (air permeability) of the gas that permeates the finishing material. The present embodiment has confirmed by experiment that the carbonation suppressing effect of the finishing material is lowered when the PVC is large using the characteristic that the air permeability of the finishing material becomes large when the PVC is large.

[0019] FIG. 1 is a graph showing the relationship between the PVC of the finishing material and an 8-week carbonation depth of the concrete.

The horizontal axis of the graph indicates PVC (%), and the vertical axis of the graph indicates the 8-week carbonation depth (mm) by the accelerated test. The points “B” and “C” in the graph indicate the PVC and the 8-week carbonation depth of water-based paint, the points “D” and “E” indicate the PVC and the 8-week carbonation depth of weak solvent paint, and the point “F” indicates the PVC and the 8-week carbonation depth of strong solvent paint. As shown in FIG. 1, the square (determination coefficient) of the correlation coefficient R between the PVC and the 8-week carbonation depth when the finishing material is water-based paint, weak solvent paint, or strong solvent paint is 0.969. Generally, if the square of the correlation coefficient R (determination coefficient) is 0.7 or more, it can be said that there is a strong correlation. From this result, it can be seen that there is a strong correlation in the relationship between the PVC and the carbonation depth regardless of whether the finishing material is water-based paint, weak solvent paint, or strong solvent paint.

[0020] In the present disclosure, “category of the finishing material”

indicates, for example, a classification of use of the finishing material, and as an example, it indicates a classification divided into “paint”, “thin finishing coating material”, and “multi-layer finishing coating material”. On the other hand, “type of the finishing material” indicates a finer type than the “category of the finishing material”. The “type of the finishing material” includes, for example, synthetic resin emulsion paint, water-based elastic acrylic resin paint (gloss), water-based acrylic resin paint (gloss), acrylic resin-based non-aqueous dispersion paint (matte), acrylic resin-based non-aqueous dispersion paint (gloss), and solvent type acrylic resin paint, which are included in the “paint”. The “type of the finishing material” includes an exterior thin coating material E, a flexible exterior thin coating material E, and a waterproof exterior thin coating material E which are included in the “thin finishing coating material”. The “type of the finishing material” further includes a multi-layer coating material E, a multi-layer coating material Si, a multi-layer coating material RE, and a waterproof multi-layer coating material E which are included in the “multi-layer finishing coating material”.

[0021] FIG. 2 is a graph showing an example of the relationship between the PVC of the finishing material and a 26-week carbonation rate coefficient of the concrete. The horizontal axis of the graph indicates the 26-week carbonation rate coefficient ($\text{mm}/\sqrt{\text{week}}$), and the vertical axis of the graph indicates PVC (%). The carbonation rate coefficient is an index indicating the rate of carbonation, and the carbonation depth is obtained by multiplying this coefficient by the square root of time. That is, as the value of the carbonation rate

coefficient is larger, the progress of carbonation is faster, and as the value of the carbonation rate coefficient is smaller, the progress of carbonation is slower. The points “B” and “C” in the graph indicate the PVC and the 26-week carbonation rate coefficient of water-based paint, the points “D” and “E” indicate the PVC and the 26-week carbonation rate coefficient of weak solvent paint, and the point “F” indicates the PVC and the 26-week carbonation rate coefficient of strong solvent paint. As shown in FIG. 2, the square (determination coefficient) of the correlation coefficient R between the PVC and the carbonation rate coefficient when the finishing material is water-based paint, weak solvent paint, or strong solvent paint is 0.7482. Therefore, from FIG. 2, it can be seen that there is a strong correlation in the relationship between the PVC and the carbonation rate coefficient regardless of whether the finishing material is water-based paint, weak solvent paint, or strong solvent paint.

[0022] FIG. 3 is a graph showing the relationship between the diffusion coefficient of the gas (carbon dioxide) that permeates the finishing material and the PVC. The horizontal axis of the graph indicates the diffusion coefficient (m^2/s) of the gas (carbon dioxide) obtained using a “box method test apparatus”, and the vertical axis of the graph indicates the PVC (%). The “box method test apparatus” is described in “RAPID EVALUATION METHODS OF CARBONATION SUPPRESSIVE PERFORMANCE OF COATING MATERIALS” described later in the electronic technical information.

Electronic technical information: [online], Yasuharu Kawamura, Kenji Motohashi, RAPID EVALUATION METHODS OF

CARBONATION SUPPRESSIVE PERFORMANCE OF COATING MATERIALS, AIJ journal of technology and design, Vol.19, No.43, pp. 825-830, 2013.10, [Search May 29, 2018], Internet <https://www.jstage.jst.go.jp/article/aijt/19/43/19_825/_pdf>.

5 [0023] The point “C” in the graph of FIG. 3 indicates the PVC and the diffusion coefficient of water-based paint, the points “D” and “E” indicate the PVC and the diffusion coefficient of weak solvent paint, and the point “F” indicates the PVC and the diffusion coefficient of strong solvent paint. As shown in FIG. 3, the square (determination
10 coefficient) of the correlation coefficient R between the PVC and the diffusion coefficient when the finishing material is water-based paint, weak solvent paint, or strong solvent paint is 0.9981, and it can be seen that there is a strong correlation in the relationship between the PVC and the diffusion coefficient regardless of whether the finishing material
15 is water-based paint, weak solvent paint, or strong solvent paint.

[0024] FIG. 4 is a graph showing another example of the relationship between the PVC and the diffusion coefficient of gas (carbon dioxide). The horizontal axis of the graph indicates the PVC (%), and the vertical axis of the graph indicates the diffusion coefficient (m^2/s) of carbon
20 dioxide. The round points (A-1, A-2, A-3, A-4, A-5 and A-6) in FIG. 4 indicate the case where the finishing material is paint, the square points (B-2 and B-3) in FIG. 4 indicate the case where the finishing material is a thin finishing coating material, and the diamond-shaped points (C-1, C-2, C-3 and C-4) in FIG. 4 indicate the case where the finishing
25 material is a multi-layer finishing coating material. As shown in FIG. 4, the square (determination coefficient) of the correlation coefficient R

between the PVC and the diffusion coefficient when the finishing material is paint, thin finishing paint, or multi-layer finishing paint is 0.824. Therefore, also from FIG. 4, it can be seen that there is a strong correlation in the relationship between the PVC and the diffusion coefficient regardless of whether the finishing material is a paint, a thin finishing paint, or a multi-layer finishing paint.

[0025] As shown in FIGS. 1 and 2, it can be seen that there is a strong correlation in the relationship between the PVC of the finishing material and the carbonation depth. Further, as shown in FIGS. 3 and 4, it can be seen that there is also a strong correlation in the relationship between the PVC of the finishing material and the diffusion coefficient of carbon dioxide. In order to evaluate the degree to which the finishing material suppresses the progress of carbonation of concrete quickly and with high accuracy, it is effective that the diffusion coefficient of carbon dioxide is calculated from the PVC of the finishing material to be evaluated using the relational expression as shown in FIG. 3 or FIG. 4, and then the progress of carbonation is predicted by applying the basic expression showing Fick's first law described later or its application expression. In the present embodiment, using the fact that there is a strong correlation in the relationship between the PVC of the finishing material and the diffusion coefficient of carbon dioxide, the diffusion coefficient of carbon dioxide is calculated from the PVC and the progress of carbonation is predicted.

[0026] FIG. 5 shows an example of an evaluation apparatus that executes the evaluation method according to the present embodiment. As shown in FIG. 5, an evaluation apparatus 1 according to the present

embodiment includes, for example, a pigment volume concentration input unit 11 to which PVC is input, a calculation unit 20 configured to calculate a diffusion coefficient and a carbonation depth, and a display unit 30 configured to display the calculation result by the calculation unit 20.

[0027] The pigment volume concentration input unit 11 receives the PVC of the finishing material obtained by measurement or the like. The PVC of the finishing material is obtained, for example, as a measured value or a value indicated by a manufacturer. For example, the PVC is measured by drying the finishing material to be measured. The value of PVC input to the pigment volume concentration input unit 11 is input to the calculation unit 20 next. The calculation unit 20 calculates, for example, a diffusion coefficient and a carbonation depth from the input PVC.

[0028] As an example, the calculation unit 20 includes a diffusion coefficient calculation unit 21, a carbonation depth calculation unit 22, and a storage unit 23. The calculation unit 20 includes, for example, a CPU (Central Processing Unit) and the storage unit 23 including a ROM (Read Only Memory) and a RAM (Random Access Memory). Each function of the calculation unit 20 is realized, for example, by loading a program stored in the ROM into the RAM and executing it by the CPU.

[0029] In the storage unit 23, a relational expression indicating the relationship between the diffusion coefficient of the gas that permeates the finishing material and the PVC (for example, the relational expression as shown in FIG. 3 or FIG. 4) is stored in advance. The diffusion coefficient calculation unit 21 calculates the diffusion

coefficient from the PVC input to the pigment volume concentration input unit 11 using the relational expression stored in the storage unit 23.

[0030] The carbonation depth calculation unit 22 calculates the carbonation depth based on the PVC input to the pigment volume concentration input unit 11 using the diffusion coefficient calculated by the diffusion coefficient calculation unit 21 from the relational expression stored in the storage unit 23. The display unit 30 displays, for example, the diffusion coefficient and the carbonation depth calculated by the calculation unit 20. As an example, the display unit 30 includes a display, and the PVC, the diffusion coefficient, and the carbonation depth are displayed on this display.

[0031] Next, an evaluation method for evaluating the concrete coated with the finishing material according to the present embodiment will be described with reference to the flowchart of FIG. 6. The flowchart in FIG. 6 shows an example of each step of the evaluation method according to the present embodiment. As an example, the evaluation method according to the present embodiment is executed when a request for extending the life or recycling of concrete is received from a designer or a contractor. The evaluation method of the present embodiment is executed, in response to such a request, for evaluating which material should be selected from a plurality of finishing materials in a case where a method for improving the durability by applying a finishing material to the surface of the concrete to suppress the progress of carbonation of the concrete is proposed. In the following, as an example, description is made of the case where the respective diffusion coefficients of the finishing material D and the finishing material E are

estimated using the relational expressions obtained in advance from the three types of finishing material A, the finishing material B, and the finishing material C, and the carbonation suppressing effects of the finishing material D and the finishing material E are evaluated. In the present embodiment, the finishing material A, the finishing material B, and the finishing material C correspond to known finishing materials, and the finishing material D and the finishing material E correspond to finishing materials to be evaluated.

[0032] First, a relational expression indicating the relationship between the PVC of the known finishing material and the diffusion coefficient is acquired and stored in the storage unit 23 (step of storing the relational expression, Step S1). The relational expression is obtained in advance as a common expression that can be applied regardless of the category of the finishing material and the type of the finishing material, for example, by conducting an experiment on the finishing material A, the finishing material B, and the finishing material C, and the obtained relational expression is stored in the storage unit 23.

[0033] Then, the PVC of each of the finishing material D and the finishing material E to be evaluated is acquired (step of acquiring the pigment volume concentration, Step S2). For example, the PVC of each of the finishing material D and the finishing material E is acquired by measurement using the measurement method described above or provision of information of the PVC from a manufacturer or the like. As an example of the measuring method, there is a method in which each of the finishing material D and the finishing material E is put in a beaker or the like and dried for about one day, and then PVC is

measured by a thermogravimetric analyzer or the like. The value of the PVC of each of the finishing material D and the finishing material E acquired by measurement or the like is input to the calculation unit 20 via the pigment volume concentration input unit 11.

5 [0034] Next, the diffusion coefficient of each of the finishing material D and the finishing material E is calculated by the diffusion coefficient calculation unit 21 from each PVC input to the calculation unit 20 (step of calculating a diffusion coefficient of gas, Step S3). The diffusion coefficient calculation unit 21 calculates the diffusion coefficient of
10 each of the finishing material D and the finishing material E using the relational expression stored in advance in the storage unit 23 from the value of each PVC.

[0035] Then, the carbonation depth of each of the finishing material D and the finishing material E is calculated by the carbonation depth
15 calculation unit 22, and the progress of carbonation over time is predicted for each of the finishing material D and the finishing material E (Step of predicting the progress of carbonation, Step S4).

[0036] An example of a method for predicting the progress of carbonation will be described below. First, the carbonation depth can
20 be calculated from the diffusion coefficient calculated above using Expression (1) below.

$$x = \frac{\sqrt{2 \cdot D \cdot C_0}}{\sqrt{H}} \cdot \sqrt{t} \quad \cdot \cdot \cdot (1)$$

x is a carbonation depth, t is time, C_0 is a concentration of carbon dioxide on a concrete surface, H is an amount of Ca(OH)_2 per

unit area of concrete, and D is a diffusion coefficient. Expression (1) uses the characteristic that the carbonation depth is proportional to the square root of time t and the square root of the concentration of carbon dioxide. Further, the degree of progress of the carbonation may be predicted from a gas flux by calculating the gas flux in the concrete using Expression (2) below.

$$J = -D \frac{dC}{dx} \quad \cdot \cdot \cdot (2)$$

Expression (2) is a basic expression showing Fick's first law, which is generally well known. Further, Expression (1) is an expression applying Fick's first law. In Expression (2), J is a gas flux (mol/m²/s), C is a gas concentration (mol/m³), D is a diffusion coefficient, and x is a carbonation depth. As described above, for example, the carbonation depth after the elapse of a certain period of time when each of the finishing material D and the finishing material E is coated on concrete is calculated. As described above, after the diffusion coefficient is calculated and the progress of the carbonation is predicted, the series of steps is completed. By performing the evaluation in such a procedure, it is possible to select a finishing material having the highest carbonation suppressing effect from among the plurality of the finishing material D and the finishing material E, so that the finishing material can be proposed.

[0037] Next, actions and effects obtained from the evaluation method according to the present embodiment will be described in detail. By performing the evaluation using the evaluation method according to the

present embodiment, the concrete coated with the finishing material is applied can be evaluated quickly and with high accuracy.

[0038] Specifically, when the evaluation is performed using the “box method test apparatus” described above, a period of about two weeks is

5 required. On the other hand, in the evaluation method of the present embodiment performed by calculating the diffusion coefficient of gas from PVC by the relational expression stored in advance, information on the PVC cannot be obtained from the manufacturer, and even when PVC measurement is required, evaluation can be performed in a few

10 days. Further, in conventional evaluation methods such as a method using the “box method test apparatus”, the test results may vary due to the influence of pinholes or uneven coating when a test specimen is created. On the other hand, in the present embodiment, since it is not

15 necessary to create a test specimen each time, there is no fear of variation in test results. That is, in the evaluation method of the present embodiment, it is possible to suppress variation in test results. Therefore, the evaluation of the concrete coated with the finishing material can be performed more quickly and with high accuracy.

[0039] In the step of storing the relational expression, in addition to obtaining the common relational expression regardless of the category of the finishing material and the type of the finishing material, a plurality of relational expressions subdivided for each category or type of the finishing material may be obtained, and the plurality of obtained relational expressions may be stored in the storage unit 23 accordingly.

25 For example, a relational expression may be obtained for each of a finishing coating material for construction, a waterproof coating

material, and paint, and the plurality of obtained relational expressions may be stored in the storage unit 23 accordingly. In this case, the finishing material to be evaluated can be evaluated with higher accuracy.

[0040] The embodiment of the evaluation method according to the present disclosure has been described above. However, the present disclosure is not limited to the embodiment described above, and may be modified or applied to other objects without changing the gist described in each claim. That is, the content of each step of the evaluation method can be variously modified without changing the gist described in each claim.

[0041] In the above-described embodiment, the example of predicting the progress of carbonation of concrete, which is a kind of deterioration of concrete caused by carbon dioxide, has been described. However, the evaluation method according to the present disclosure is not limited to the above example. For example, as another embodiment, the progress of corrosion of a reinforcing bar in reinforced concrete caused by oxygen may be predicted. In this case, it is possible to calculate the oxygen diffusion coefficient from PVC using the strong correlation between the PVC of the finishing material and the diffusion coefficient of the gas, and to predict the progress of corrosion of a reinforcing bar in reinforced concrete. As an example of a method for predicting the progress of corrosion of a reinforcing bar, for example, Expression (3) and Expression (4) using Fick's first law described below are used. Expressions (3) and (4) correspond to the expressions 6.1.5 in p.199 and the expressions in p.212 in "Concrete Structure Repair Method Research Committee Report (III)" (1996.10) by the Japan Concrete

Institute.

$$i_{corr} = \frac{4DF}{\delta} c \quad \cdot \cdot \cdot (3)$$

$$w_{Fe} = 9.145 \times 10^6 \cdot i_{corr} \quad \cdot \cdot \cdot (4)$$

i_{corr} is an amount of corrosion current (A/cm²) determined by an oxygen supply rate to the reinforcing bar, D is an oxygen diffusion coefficient (cm²/s), F is a Faraday constant, δ is a covering thickness of the reinforcing bar (cm), c is an oxygen concentration of a concrete surface (mol/cm³), and w_{Fe} is a corrosion rate (mg/cm²/year). w_{Fe} (corrosion rate (mg/cm²/year)) expresses how many mg of iron dissolves per year in the region of 1 cm² on the reinforcing bar surface. With the above expressions (3) and (4), it is possible to predict the progress of corrosion of the reinforcing bar. The relational expression used for predicting the progress of corrosion of the reinforcing bar is not limited to the above expressions (3) and (4), and can be changed as appropriate.

[0042] In the above-described embodiment, the example of performing the evaluation using the evaluation apparatus 1 including the pigment volume concentration input unit 11, the calculation unit 20, and the display unit 30 has been described. However, the configurations of the pigment volume concentration input unit, the calculation unit, and the display unit can be changed as appropriate, and the configuration of the evaluation apparatus can be changed as appropriate.

Reference Signs List

[0043]

- 1 evaluation apparatus
- 11 pigment volume concentration input unit
- 20 calculation unit
- 5 21 diffusion coefficient calculation unit
- 22 carbonation depth calculation unit
- 23 storage unit
- 30 display unit

WHAT IS CLAIMED IS:

1. An evaluation method for evaluating concrete coated with a finishing material, comprising:

5 a step of acquiring and storing in advance a relational expression between a diffusion coefficient of gas that permeates a known finishing material and a pigment volume concentration, the relational expression being specified for the known finishing material;

10 a step of acquiring a pigment volume concentration of a finishing material to be evaluated; and

a step of calculating a diffusion coefficient of gas that permeates the finishing material to be evaluated from the obtained pigment volume concentration.

15 2. The evaluation method according to claim 1, further comprising

a step of predicting progress of carbonation of the concrete coated with the finishing material to be evaluated, after the step of calculating the diffusion coefficient of the gas.

20 3. The evaluation method according to claim 1, further comprising

a step of predicting progress of corrosion of a reinforcing bar embedded in the concrete coated with the finishing material to be evaluated, after the step of calculating the diffusion coefficient of the gas.