

DESCRIPTION

Title of Invention

QUICK-HARDENING REPAIR MORTAR MATERIAL, QUICK-HARDENING REPAIR MORTAR COMPOSITION, AND HARDENING BODY

Technical Field

[0001]

The present invention relates to a quick-hardening repair mortar material, a quick-hardening repair mortar composition, and a hardening body that are used in repair and reinforcement constructions of concrete structures in the fields of civil engineering and construction.

Background Art

[0002]

A concrete structure is deteriorated by actions such as salt damage, carbonation, freezing-thawing, and chemical corrosion, and cracking, floating, and the like may occur on the surface of the concrete structure. As a countermeasure against this, repair construction in which a deteriorated portion is examined by a hammering test or the like, removed by an electric hammer, an air hammer, a water jet, or the like, and newly filled with a repair material is carried out.

In small-scale repair construction in which a cross section to be repaired is small, cross-section repair is often carried out by kneading polymer cement mortar and troweling the polymer cement mortar (see, for example, PTLs 1 and 2).

[0003]

For repair by troweling or the like, a material having favorable workability, such as quick-hardening properties, ease of kneading, and thick-coating properties of used mortar, is required. A material in which an inorganic fine powder, such as fly ash and silica fume, is blended as described in PTLs 1 and 2 to impart appropriate stickiness and resistance to dripping to mortar, or a material in which cellulose ethers are blended (see, for example, NPL 1 and PTLs 3 to 6) is used. In use of cellulose ethers, the viscosity is increased and water retention properties are favorable, but resistance during kneading is increased. Therefore, there are problems about thick-coating properties that a load is applied to a mixer and an operator and mortar is bonded to a trowel during plastering finishing.

[0004]

When a hardening substance is made dense by mixing a polymer emulsion, the polymer cement mortar suppresses the permeability of carbon dioxide, chloride ions, and water to impart durability, but complete blockage cannot be achieved. In particular, the polymer cement mortar may be shrunk by diffusion of water at a stage prior to hardening, and cracked at an initial stage and after several months. In order to solve this problem, a dry shrinkage reducing admixture is also blended (see, for example, PTLs 7 and 8). However, the dry shrinkage reducing admixture delays setting, and therefore initial crack may be formed by water diffusion at the stage prior to hardening, to decrease durability. In general, cellulose ethers also delay setting.

[0005]

Furthermore, there are problems of low flowability, high resistance during kneading, and low constructability, and risks that a hardening body is cracked by corrosion of reinforcing bars due to carbonation and bonding performance to a structure is decreased. Therefore, an object is to achieve excellent flowability and kneading resistance and higher bonding strength to the reinforcing bars, resulting in integrity with the structure and ensuring durability.

Citation List

Patent Literature

[0006]

PTL 1: JP 2001-322858 A

PTL 2: JP 2003-89565 A

PTL 3: JP 11-349364 A

PTL 4: JP 2000-103662 A

PTL 5: JP 2000-128617 A

PTL 6: JP 06-219807 A

PTL 7: JP 2003-55018 A

PTL 8: JP 10-324555 A

Non-Patent Literature

[0007]

NPL 1: Shin Suiyousei polymer no ouyou to shijo, edited by Nagatomo, Shinji, published by CMC publishing Co., Ltd., pp. 173-192, 1988

Summary of Invention

Technical Problem

[0008]

It is an object of the present invention to provide a quick-hardening repair mortar material that contains a specific amount of chlorine and includes a combination of a specific material with fine aggregate, and thus can achieve high flowability and low kneading resistance and increase carbonation resistance, bonding strength to a reinforcing bar, and rust prevention ratio of the reinforcing bar, a quick-hardening repair mortar composition, and a hardening body.

Solution to Problem

[0009]

The present invention has been made to solve the problems. In order to solve the problems, the present inventors have made various efforts, and as a result found that a quick-hardening repair mortar material that contains a specific amount of chlorine and includes a combination of a specific material with fine aggregate can achieve high flowability, decrease kneading resistance, further increase carbonation resistance, bonding strength to a reinforcing bar, and rust prevention ratio of the reinforcing bar, and improve durability. Thus, the present invention has been completed. The outline of the present invention is as follows:

[1] A quick-hardening repair mortar material including cement, calcium aluminate, gypsum, polymer emulsion, fibers, and fine aggregate, the quick-hardening repair mortar material having a chlorine amount of 3 ppm or more and 1,800 ppm or less.

[2] The quick-hardening repair mortar material according to [1], in which the fine aggregate contains as chemical components 85% by mass or more of CaO and 0.2% by mass or more and 15% by mass or less of SiO_2 .

[3] The quick-hardening repair mortar material according to [1] or [2], in which the fine aggregate has a decreased fineness modulus in accordance with JIS A 1121 "test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine" of 70% or more and 100% or less.

[4] The quick-hardening repair mortar material according to any one of [1] to [3], in which the fine aggregate contains as chemical components 40 ppm or more and 3,000 ppm or less of K_2O , 40 ppm or more and 3,000 ppm or less of SO_3 , 0.1% by mass or more and 3.0% by mass or less of Fe_2O_3 , and 0.1% by mass or more and

3.0% by mass or less of Al_2O_3 .

[5] The quick-hardening repair mortar material according to any one of [1] to [4], in which a content ratio of the fine aggregate is 40 parts by mass or more and 300 parts by mass or less relative to 100 parts by mass of the cement.

[6] A quick-hardening repair mortar composition including the quick-hardening repair mortar material according to any of [1] to [5] and water.

[7] A hardening body obtained by using the quick-hardening repair mortar composition according to [6].

Advantageous Effects of Invention

[0010]

The present invention can provide a quick-hardening repair mortar material that contains a specific amount of chlorine and includes a combination of a specific material with fine aggregate, and thus can achieve high flowability and low kneading resistance and further increase carbonation resistance, bonding strength to a reinforcing bar, and rust prevention ratio of the reinforcing bar, a quick-hardening repair mortar composition, and a hardening body.

Description of Embodiments

[0011]

Hereinafter, the present invention will be described in detail.

Part(s) and % in this description are based on mass unless other specified.

A quick-hardening repair mortar composition used herein is a generic term of paste containing no coarse aggregate and mortar containing fine aggregate.

[0012]

A quick-hardening repair mortar material of the present invention contains cement, calcium aluminate, gypsum, polymer emulsion, fibers, and fine aggregate, and has an amount of chlorine of 3 ppm or more and 1,800 ppm or less.

An attention is paid to the amount of chlorine contained in the quick-hardening repair mortar material of the present invention. It is found that the amount of chlorine affects the bonding strength of the quick-hardening repair mortar material to a reinforcing bar. In other words, when the amount of chlorine contained in the quick-hardening repair mortar material is less than 3 ppm, the bonding strength to the reinforcing bar may be decreased. When the amount of chlorine contained in the quick-hardening repair mortar material is more than

1,800 ppm, a rust prevention effect may be decreased.

From the viewpoint of improving the bonding strength to the reinforcing bar, the amount of chlorine contained in the quick-hardening repair mortar material is preferably 30 ppm or more, more preferably 40 ppm or more, further preferably 50 ppm or more, still more preferably 100 ppm or more, and particularly preferably 150 ppm or more. From the viewpoint of improving the rust prevention effect due to carbonation and improving durability, the amount of chlorine contained in the quick-hardening repair mortar material is required to be 3 ppm or more and 1,800 ppm or less, and is preferably 1,600 ppm or less, more preferably 1,500 ppm or less, and further preferably 1,400 ppm or less.

[0013]

The amount of chlorine contained in the quick-hardening repair mortar material can be adjusted, for example, by adding an admixture containing chlorine for production of the quick-hardening repair mortar material. The amount of chlorine can be measured by a method described in Examples described below.

[0014]

The cement used in the present invention is not particularly limited, and examples thereof include various types of cement, such as normal, high-early-strength, ultra-high-early-strength, low heat, and moderate heat cement, various types of mixed cement obtained by mixing blast furnace slag, fly ash, or silica fume with the aforementioned cement, environmentally friendly cement (eco-cement) produced using, as a raw material, urban refuse incineration ash or sewage sludge incineration ash, and commercially available fine particle cement. The various types of cement or the various types of mixed cement can be pulverized for use. The amount of component (e.g., gypsum) usually used in cement can be adjusted, that is, increased or decreased for use.

In the present invention, normal Portland cement or high-early-strength Portland cement is preferably selected from the viewpoint of high flowability, carbonation resistance, bonding strength to a reinforcing bar, and rust prevention.

[0015]

From the viewpoint of production cost and strength development, Blaine's specific surface area (hereinafter also referred to as Blaine's value) of the cement used in the present invention is preferably 2,500 cm²/g or more and 7,000 cm²/g or less, more preferably 2,750 cm²/g or more and 6,000 cm²/g or less, and further preferably 3,000 cm²/g or more and 4,500 cm²/g or less.

The Braine's specific surface area is determined in accordance with JIS R 5201 (Physical Test Method for Cement).

[0016]

The calcium aluminate (CA) used in the present invention is a generic term of a compound containing as main component CaO and Al_2O_3 . Specific examples thereof include an amorphous compound containing as main components a CaO component and an Al_2O_3 component, and crystalline calcium aluminates represented by $\text{CaO} \cdot 2\text{Al}_2\text{O}_3$, $\text{CaO} \cdot \text{Al}_2\text{O}_3$, $12\text{CaO} \cdot 7\text{Al}_2\text{O}_3$, $11\text{CaO} \cdot 7\text{Al}_2\text{O}_3 \cdot \text{CaF}_2$, and $3\text{CaO} \cdot 3\text{Al}_2\text{O}_3 \cdot \text{CaF}_2$.

In particular, the molar ratio of CaO to Al_2O_3 in CAO is preferably within the range of 0.75 to 3, and more preferably within the range of 1 to 2. When the molar ratio of CaO to Al_2O_3 is 0.75 or more, sufficient initial strength development is obtained. When the molar ratio of CaO to Al_2O_3 is 3 or less, sufficient flowability and pot-life are achieved.

Amorphous calcium aluminate is preferred. In a case of crystalline calcium aluminate, sufficient strength development may not be obtained.

[0017]

Examples of a method for obtaining CA include a method in which a CaO raw material, an Al_2O_3 raw material, and the like are heat-treated by a rotary kiln, an electric furnace, or the like.

Examples of the CaO raw material for production of CA include calcium carbonate, such as limestone and seashell, calcium hydroxide, such as slaked lime, and calcium oxide, such as quick lime.

Examples of the Al_2O_3 raw material include an industrial byproduct called bauxite or aluminum residual ash.

[0018]

Industrially obtained CA may contain impurities. Specific examples of the impurities include SiO_2 , Fe_2O_3 , MgO , TiO_2 , MnO , Na_2O , K_2O , Li_2O , S, P_2O_5 , and F. The presence of the impurities does not particularly matter within a range where the purpose of the present invention is not substantially impaired. Specifically the presence of the impurities does not particularly matter within a range where the total amount of the impurities is 10% or less.

[0019]

The particle size of CA in the present invention is not particularly limited. In general, the Blaine's value is usually 3,000 to 9,000 cm^2/g , and more preferably

4,000 to 8,000 cm²/g. When the Blaine's value of CA is 3,000 cm²/g or more, initial strength development can be sufficiently exerted. When the Blaine's value of CA is 9,000 cm²/g or less, ensuring flowability and pot-life is facilitated.

[0020]

In the present invention, CA having an ignition loss of 1% or more is preferably used, and CA having an ignition loss of 2% or more is more preferably used. When the ignition loss of CA is 1% or more, ensuring flowability and pot-life is facilitated, and the generation of "spots" can be suppressed.

A method for adjusting the ignition loss to 1% or more is not particularly limited, and examples thereof include a method for supplying a water content or a moisture content, and a method for supplying carbon dioxide.

[0021]

The gypsum used in the present invention is a generic term of anhydrous, hemihydrate, and dihydrate gypsum respectively, and is not particularly limited. From the viewpoint of strength development, anhydrous or hemihydrate gypsum is preferably used, and anhydrous gypsum is more preferably used.

[0022]

The particle size of the gypsum is not particularly limited. In general, the Blaine's value is preferably 3,000 to 9,000 cm²/g, and more preferably 4,000 to 8,000 cm²/g. When the Blaine's value of the gypsum is 3,000 cm²/g or more, dimensional stability is favorable. When the Blaine's value of the gypsum is 9,000 cm²/g or less, ensuring flowability is facilitated.

[0023]

It is preferable that in 100 parts by mass of binding material including the cement, CA, and the gypsum, the blending ratio of the cement is 50 to 98 parts by mass, the blending ratio of CA is 1 to 25 parts by mass, and the blending ratio of the gypsum is 1 to 25 parts by mass respectively. When the blending ratios of the materials are within the ranges, a quick-hardening repair mortar material satisfying the effects of the present invention, that is, a quick-hardening repair mortar material having high flowability and excellent carbonation resistance, bonding strength to a reinforcing bar, and rust prevention can be obtained.

[0024]

Herein, it is preferable that in 100 parts by mass of quick-hardening component including CA and the gypsum, the blending ratio of CA is 30 to 70 parts by mass and the blending ratio of the gypsum is 70 to 30 parts by mass, and it is

more preferable that the blending ratio of CA is 40 to 60 parts by mass and the blending ratio of the gypsum is 60 to 40 parts by mass. When the blending ratio of CA is 30 parts by mass or more and the mixing ratio of the gypsum is 70 parts by mass or less, the initial strength development is sufficient, and dimensional stability is favorable. When the blending ratio of CA is 70 parts by mass or less and the blending ratio of the gypsum is 30 parts by mass or more, ensuring pot-life is facilitated.

[0025]

The mixing ratio of the quick-hardening component is preferably 2 to 50 parts by mass, and more preferably 10 to 40 parts by mass, relative to 100 parts by mass of the cement. When the blending ratio of the quick-hardening component is less than 2 parts by mass, the strength development is equal to or more than the initial strength development, thereby making material segregation resistance favorable. When the blending ratio of the quick-hardening component is 50 parts by mass or less, a quick-hardening repair mortar material having high flowability, low kneading resistance, and excellent carbonation resistance, bonding strength to a reinforcing bar, and rust prevention is obtained.

[0026]

The polymer emulsion used in the present invention is not particularly limited, and examples thereof include rubber latex, such as acrylonitrile-butadiene rubber, styrene-butadiene rubber, chloroprene rubber, and natural rubber, and resin emulsion, such as an ethylene-vinyl acetate copolymer, acrylic acid ester-based copolymers typified by a polyacrylic acid ester, a styrene-acrylate copolymer, and an acrylonitrile-acrylic acid ester, and a vinyl acetate-vinyl versatate-based copolymer.

The form of the polymer includes a re-emulsifiable powder form and a liquid form. The polymer emulsion is used to improve bonding properties to a substrate portion and enhance the durability of mortar.

[0027]

In general, the amount of used polymer emulsion is usually a solid content relative to 100 parts by mass of the cement, and is preferably 1 to 15 parts by mass, and more preferably 3 to 10 parts by mass. When the amount of used polymer emulsion is within the range, kneading resistance can be decreased, and carbonation resistance and bonding strength can be increased.

[0028]

The fibers used in the present invention improve thick-coating properties and cracking resistance.

The types of the fibers are not particularly limited, and examples of the fibers include a polymeric fiber, such as a vinylon fiber, a propylene fiber, an acryl fiber, a nylon fiber, an aramid fiber, and an inorganic fiber, such as a steel fiber, a glass fiber, a carbon fiber, and a fiber obtained by melt-spinning a rock such as basalt.

[0029]

The amount of used fibers is preferably 0.02 to 1.5 parts by mass, and more preferably 0.05 to 1.0 parts by mass, relative to 100 parts by mass of the cement. When the amount of used fibers is 0.02 parts by mass or more, an effect of improving dripping properties can be sufficiently exerted. When the amount of used fibers is 1.5 parts by mass or less, kneading resistance can be improved.

From the viewpoint of favorable appearance of a troweling-finished surface, the length of the fibers is preferably 15 mm or less, more preferably 12 mm or less, and further preferably 10 mm or less.

[0030]

It is preferable that the fine aggregate used in the present invention contain as chemical components 85% by mass or more of CaO and 0.2% by mass or more and 15% by mass or less of SiO₂. When the ratios of CaO and SiO₂ as the chemical components of the fine aggregate are within the ranges, a quick-hardening repair mortar material having high flowability and excellent carbonation resistance, bonding strength to a reinforcing bar, and rust prevention is obtained.

The ratio of CaO is preferably 87% by mass or more, more preferably 89% by mass or more, and further preferably 91% by mass or more. The upper limit of the ratio of CaO is not particularly limited, and is preferably 99% by mass or less, and more preferably 98.5% by mass or less.

The ratio of SiO₂ is preferably 0.25% by mass or more and 13% by mass or less, more preferably 0.3% by mass or more and 11% by mass or less, and further preferably 0.4% by mass or more and 10% by mass or less.

In order to adjust the ratios of the chemical components of the fine aggregate within the ranges and within a range described below, silica sand, calcite, scapolite that is metamorphic rock, quartz that is igneous rock, potash feldspar, and the like are mixed to prepare the fine aggregate. While the chemical

components are checked by X ray fluorescence diffraction to satisfy the scope of the present invention, each rock is mixed for adjustment. For the chemical components of the fine aggregate used in the present invention, the ratios are calculated in terms of oxide.

[0031]

It is preferable that the fine aggregate used in the present invention contain as the chemical components K_2O , SO_3 , Fe_2O_3 , and Al_2O_3 . The fine aggregate containing K_2O , SO_3 , Fe_2O_3 , and Al_2O_3 can contribute to high flowability, carbonation resistance, bonding strength to a reinforcing bar, and rust prevention.

The ratio of K_2O is preferably 40 ppm or more and 3,000 ppm or less, more preferably 50 ppm or more and 2,500 ppm or less, further preferably 60 ppm or more and 2,250 ppm or less, and still more preferably 70 ppm or more and 2,000 ppm or less.

The ratio of SO_3 is preferably 40 ppm or more and 3,000 ppm or less, more preferably 50 ppm or more and 2,500 ppm or less, further preferably 60 ppm or more and 2,250 ppm or less, and still more preferably 70 ppm or more and 2,000 ppm or less.

The ratio of Fe_2O_3 is preferably 0.1% by mass or more and 3.0% by mass or less, more preferably 0.13% by mass or more and 2.5% by mass or less, and further preferably 0.15% by mass or more and 2.0% by mass or less.

The ratio of Al_2O_3 is preferably 0.1% by mass or more and 3.0% by mass or less, more preferably 0.13% by mass or more and 2.5% by mass or less, and further preferably 0.15% by mass or more and 2.0% by mass or less.

[0032]

The decreased fineness modulus of the fine aggregate used in the present invention in accordance with JIS A 1121 "test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine" is preferably 70% or more and 100% or less, more preferably 75% or more and 99% or less, further preferably 80% or more and 98% or less, and still more preferably 85% or more and 97% or less. When the decreased fineness modulus of the fine aggregate is the lower limit value or more, the bonding force to a reinforcing bar can be increased. When the decreased fineness modulus of the fine aggregate is the upper limit value or less, carbonation resistance can be increased. This contributes to the suppression of rusting of the reinforcing bar due to carbonation resistance. The "fineness modulus of the fine aggregate" in the description is a value determined from a

result of sieving. The value refers to an index indicating the general value of size of the fine aggregate. The "decreased fineness modulus of the fine aggregate" in the description refers to a proportion by which the fineness modulus after a test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine is lower than the fineness modulus before the test in comparison between the fineness modulus before the test and the fineness modulus after the test.

In order to adjust the proportion by which the fineness modulus of the fine aggregate is decreased within the range, silica sand, calcite, scapolite that is metamorphic rock, quartz that is igneous rock, potash feldspar, and the like are mixed to prepare the fine aggregate. While the decreased fineness modulus of the fine aggregate is checked to satisfy the scope of the present invention at the test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine, each rock is mixed for adjustment.

When the decreased fineness modulus of the fine aggregate is within the range, the production area or origin of the fine aggregate is not particularly limited.
[0033]

The content ratio of the fine aggregate is preferably 40 parts by mass or more and 300 parts by mass or less, more preferably 75 parts by mass or more and 250 parts by mass or less, and further preferably 100 parts by mass or more and 200 parts by mass or less, relative to 100 parts by mass of the cement. When the content ratio of the fine aggregate is the lower limit value or more, a heat value can be decreased, shrinkage can be suppressed, and cracking can be suppressed. When the content ratio of the fine aggregate is the upper limit value or less, a quick-hardening repair mortar material having high flowability and excellent resistance to salt damage, bonding strength to a reinforcing bar, and rust prevention can be obtained.

[0034]

From the viewpoint of improving strength development, enhancing acid resistant, acquiring a pot-life, and improving dimensional stability, the quick-hardening repair mortar material of the present invention may contain a siliceous fine powder in addition to the cement, the calcium aluminate, the gypsum, the polymer emulsion, the fibers, and the fine aggregate.

[0035]

Examples of the siliceous fine powder include a latent hydraulic substance, such as ground granulated blast furnace slag fine powder, and a pozzolan

substance, such as fly ash and silica fume. In particular, silica fume is preferred.

The type of silica fume is not limited. From the viewpoint of flowability, silica fume containing 10% or less of ZrO_2 or acidic silica fume is more preferably used as impurities. The acidic silica fume is silica fume exhibiting acidity such that a supernatant liquid obtained by adding 1 g of silica fume to 100 cc of pure water followed by stirring has a PH of 5.0 or less.

[0036]

The fineness of the siliceous fine powder is not particularly limited. In general, the Blaine's values of ground granulated blast furnace slag and fly ash are within the range of 3,000 cm^2/g or more and 9,000 cm^2/g or less, and the BET specific surface area of silica fume is within the range of 20,000 cm^2/g or more and 300,000 cm^2/g or less.

[0037]

The content ratio of the siliceous fine powder is preferably 1 part by mass or more and 20 parts by mass or less, more preferably 2 parts by mass or more and 15 parts by mass or less, and further preferably 3 parts by mass or more and 10 parts by mass or less, relative to 100 parts by mass of the cement. When the content ratio of the siliceous fine powder is the lower limit value or more, the strength development can be improved, the acid resistant can be enhanced, the pot-life can be obtained, and dimensional stability can be favorable. When the content ratio of the siliceous fine powder is the upper limit value or less, flowability can be increased, and the bonding force to a reinforcing bar and the rust prevention effect can be improved.

[0038]

In the present invention, a defoamer may be used within a range that does not adversely affect performance. The defoamer is used to reduce the amount of air contained by kneading.

The type of the defoamer is not particularly limited as long as the defoamer does not significantly adversely affect strength characteristics of hardening mortar. The defoamer may be used in a liquid state or a powder state. Examples of the defoamer include a polyether-based defoamer, a polyhydric alcohol-based defoamer, such as an esterified product or an alkylether of a polyhydric alcohol, an alkyl phosphate-based defoamer, and a silicone-based defoamer.

[0039]

The amount of used defoamer is preferably 0.002 to 0.5 parts by mass, and

more preferably 0.01 to 0.4 parts by mass, relative to 100 parts by mass of the cement. When the amount of used defoamer is the lower limit value or more, a defoaming effect can be sufficiently exerted. When the amount of used defoamer is the upper limit value or less, a decrease in bonding strength to a reinforcing bar can be suppressed.

[0040]

In the present invention, a setting retardant can be used to control the pot-life. Examples of type of the setting retardant include oxycarboxylic acids, such as citric acid, tartaric acid, gluconic acid, and malic acid, and metal salts thereof, phosphoric acid salts, such as tripolyphosphoric acid salt and sodium primary phosphate, saccharides, such as sucrose and fructose, boric acid salts, such as sodium borate, and a silicofluoride, such as magnesium silicofluoride. One type of setting retardant may be used or two or more types thereof may be used in combination.

The setting retardant may be also used in combination with a carbonic acid salt, a sulfuric acid salt, a nitric acid salt, a nitrous acid salt, or the like.

[0041]

The amount of used setting retardant is preferably 0.05 to 2 parts by mass, and more preferably 0.1 to 1 parts by mass, relative to 100 parts by mass of the cement. When the amount of used setting retardant is the lower limit value or more, setting can be suitably delayed. When the amount of used setting retardant is the upper limit value or less, the inhibition of strength development can be suppressed.

[0042]

In the present invention, one or two or more of admixture materials, such as a gas-foaming substance, an expansive additive, a water reducer, an air-entraining agent, an antirust agent, a water repellent, an antibacterial agent, a colorant, an antifreezing agent, limestone fine powder, air-cooled blast furnace slag fine powder, sewage sludge incineration ash and melt slag thereof, urban refuse incineration ash and melt slag thereof, and pulp sludge incineration ash, a thickener, a shrinkage reducing agent, a polymer, a clay mineral, such as bentonite and sepiolite, and an anionic exchanger, such as hydrotalcite, can be used within a range that does not adversely affect performance and a range that does not substantially impair the purpose of the present invention.

[0043]

A method for mixing materials in the quick-hardening repair mortar material of the present invention is not particularly limited. The materials may be mixed in working, or a part or the entire thereof may be mixed in advance.

As a mixing device, any existing device, for example, a tilting mixer, an Omni mixer, a Henschel mixer, a V-type mixer, a Nauta mixer, or the like can be used.

[0044]

A quick-hardening repair mortar composition of the present invention contains the quick-hardening repair mortar material of the present invention and water.

The amount of kneaded water in the quick-hardening repair mortar composition of the present invention is not particularly limited since it varies depending on use purpose, use application, and the content ratio of each of the materials. The amount of kneaded water is preferably 10 parts by mass or more and 70 parts by mass or less, more preferably 14 parts by mass or more and 65 parts by mass or less, and further preferably 16 parts by mass or more and 60 parts by mass or less, relative to 100 parts by mass of the quick-hardening repair mortar material. When the amount of kneaded water is the lower limit value or more, a decrease in flowability can be suppressed, and an extreme increase in heat value can be suppressed. When the amount of kneaded water is the upper limit value or less, the strength development can be achieved.

[0045]

Examples of a repair method using the quick-hardening repair mortar composition of the present invention include a method in which a predetermined amount of water is added and kneaded and the the quick-hardening repair mortar composition is applied to a repair portion by a trowel, and a method in which the the quick-hardening repair mortar composition kneaded is transferred under pressure to a degree that does not affect working by a pump as needed, then blown toward a repair portion by compressed air, and finished by a trowel. A kneading method may include a method in which a material is placed in a container, such as a pail can, and kneaded by a handheld mixer, and a kneading method by a pan mixer or the like. The quick-hardening repair mortar composition of the present invention is kneaded and applied to form a hardening body.

In a specific example of the repair method, a deteriorated concrete portion is removed by a water jet, and a primer is then applied. Subsequently, kneaded

mortar is applied by a trowel or by spraying. Since mortar can be applied once to a wall surface or a ceiling surface so as to have a thickness of about 30 mm for repair, the surface may be finished by a trowel. When the thickness for repair is more than 30 mm, the mortar is divided into multiple layers, and repair is carried out. In this case, a construction joint surface is crudely finished, but is not smoothly finished by a trowel. Thus, a bonding force can be obtained. Although timing of jointing varies depending on an ambient temperature and the like, jointing may be carried out when hardening proceeds to a degree that the already applied mortar is not recessed by touching with the finger. Finally, the surface is finished by a trowel to be made smooth. For careful working, it is preferable that a countermeasure against drying be carried out using a curing sheet, a curing agent, or the like.

Examples

[0046]

Hereinafter, the present invention will be further described on the basis of Experimental Examples of the present invention, but the present invention is not limited to the Examples.

[0047]

Experimental Example 1

Preparation was carried out by adding 8 parts by mass of CA, 8 parts by mass of gypsum, 5 parts by mass of polymer emulsion, 0.6 parts by mass of fivers, 120 parts by mass of fine aggregate, and 1 part by mass of setting retardant to 100 parts by mass of cement. Thus, a quick-hardening repair mortar material was obtained. Subsequently, a chlorine-containing admixture (material name: sodium chloride) was mixed in the quick-hardening repair mortar material. Thus, the quick-hardening repair mortar material was prepared.

With 100 parts by mass of the prepared quick-hardening repair mortar material, 23 parts by mass of water was kneaded to prepare a quick-hardening repair mortar composition.

The chlorine concentration, flowability, kneading resistance, carbonation depth, bonding strength, and rusting ratio of the prepared quick-hardening repair mortar composition were measured. The results are shown together in Table 1.

[0048]

<Used Materials>

· Cement: test cement (for adjustment of raw materials mixed in a cement factory

and chemical components, various types of commercially available pure substances were used, and for adjustment of SO_3 amount, pure anhydrous gypsum was used), chlorine amount: 1.5 ppm, Blaine's value: 3,450 cm^2/g

· Ca:CaO/ Al_2O_3 molar ratio: 1.70, ignition loss: 1.0%, crystalline, main component: CaO · Al_2O_3 and 12CaO · 7 Al_2O_3 , Blaine's value: 5,000 cm^2/g

· Gypsum: anhydrous gypsum, commercially available product, Blaine value: 4,000 cm^2/g

· Polymer emulsion: polyacrylic acid ester-re-emulsified resin, commercially available product, water content: 0.8%, density: 0.5 g/mL

· Fibers: vinylon fibers, fiber length: 6 mm, fineness: 6.6 dtex, dry strength: 1,850 N/mm², dry elongation: 6.0%

· Setting retardant: citric acid of first grade reagent

· Water: tap water

· Fine aggregate: A test was carried out using components of fine aggregate shown in Table 1. The chemical components in the fine aggregate were measured by X ray fluorescence diffraction. For preparation of the chemical components, silica sand (Aichi prefectural), calcite (CaCO_3), scapolite as metamorphic rock ((Na, Ca, K)₄Al₄Si₉O₂₄(Cl, CO₃, SO₄)), quartz as igneous rock (SiO_2), and potash feldspar (KAlSi_3O_8) were mixed to prepare the chemical components.

[0049]

<Measurement Items>

· Chlorine concentration: the chlorine concentration of the prepared quick-hardening repair mortar composition was measured in accordance with JIS R 5202.

· Flowability: a flow value was measured in an environment of 20°C in accordance with JIS R 5201.

· Kneading resistance: the quick-hardening repair mortar composition was kneaded for 90 seconds by a handheld mixer for mortar mixing in an environment of 20°C, a current value at this time was measured by a clamp meter, and the maximum value thereof was considered as an indication of kneading resistance.

· Carbonation depth: aging was carried out in water at 20°C until an age of 28 days, and carbonation was accelerated in an environment of 30°C, a relative humidity of 60%, and a carbon dioxide concentration of 5% for 12 weeks. After the carbonation was accelerated, an alcohol solution of 1% phenolphthalein was sprayed onto a mortar cross section, and the depth from the surface to a colored portion was measured and confirmed as a carbonation depth. Carbonation

resistance was evaluated.

- Bonding strength: A bonding strength to a reinforcing bar when a round steel bar with a diameter of 19 mm that was embedded at an embedded depth of 16 cm was drawn was determined. Aging was sealing aging at 20°C. A test was carried out for an age of 28 days.

- Rusting ratio of reinforcing bar: Ultra-rapid-hardening mortar was poured such that a round steel bar with a diameter of 19 mm embedded at an embedded depth of 18 cm was covered at a cover thickness of 10 mm. Aging was carried out in water at 20°C until an age of 28 days, and carbonation was accelerated in an environment of 30°C, a relative humidity of 60%, and a carbon dioxide concentration of 5% for 12 weeks. During a carbonation acceleration test, a specimen was taken out every three weeks, and immersed in water for one day in an environment of 20°C. Thus, the carbonation acceleration test was carried out. After termination of the test, the round steel bar was taken out, rust was removed with a 10% diammonium citrate solution, the weight (m_2) of the round steel bar after the test was measured, and the rusting ratio of the reinforcing bar was calculated by the following expression based on a change between the weight (m_2) and the weight (m_1) of the round steel bar before the test.

$$\text{Rusting ratio of reinforcing bar (\%)} = [(m_1 - m_2) / m_1] \times 100$$

[0050]

[Table 1]

No.	CaO	SiO ₂	Chlorine	Flowability	Kneading resistance	Carbonation depth	Bonding strength	Rusting ratio of reinforcing bar		Remark
	% by mass	% by mass	ppm	sec	A	mm	N/mm ²		%	
1-1	91	4.8	1	148	13	4.2	4.1	6		Comparative Example
1-2	91	4.8	3	163	9	2.1	5.3	0		Example
1-3	91	4.8	200	165	7	2	5.6	0		Example
1-4	91	4.8	1800	159	9	2.3	5.4	1		Example
1-5	91	4.8	2200	143	13	4.3	4.2	7		Comparative Example
1-6	10	83	200	156	9	2.6	5.0	3		Example
1-7	85	4.9	210	162	8	2.3	5.5	1		Example
1-8	92	0.2	210	162	8	2.4	5.4	1		Example
1-9	91	4.8	190	165	7	2	5.6	0		Example
1-10	90	15	200	163	8	2.6	5.3	1		Example
1-11	91	4.9	190	160	7	2.2	5.4	0		Example
1-12	90	4.8	190	160	8	2.3	5.3	1		Example

[0051]

As confirmed from the results of Table 1, when a specific amount of chlorine is contained and fine aggregate including a specific chemical component is used, flowability is high, and kneading resistance, carbonation resistance, bonding strength to the reinforcing bar, rusting ratio of the reinforcing bar can be reduced.

[0052]

Experimental Example 2

The same operation as in Experimental Example 1 was carried out except that fine aggregate shown in Table 2 was blended to prepare a quick-hardening repair mortar composition. The results are shown together in Table 2.

At a test for resistance to abrasion of fine aggregate by use of the Los Angeles machine, 5 kg of fine aggregate and 6 iron balls were introduced into the Los Angeles machine. The average diameter of the iron balls was about 46.8 mm, and the weight of each of the iron balls was 390 to 445 g. The Los Angeles machine was then rotated 500 times (at 30 revolutions per minute). Subsequently, the fine aggregate collected from the Los Angeles machine was sieved by a metal screen sieve with a mesh size of 5 mm, 2.5 mm, 1.2 mm, 0.6 mm, 0.3 mm, or 0.15 mm. The fineness modulus (R_1) of the fine aggregate before introduction into the Los Angeles machine was compared with the fineness modulus (R_2) of the fine aggregate after introduction into the Los Angeles machine, and the decreased fineness modulus after the test was calculated by the following expression.

$$\text{Decreased fineness modulus} = R_2/R_1$$

[0053]

[Table 2]

No.	CaO	SiO ₂	Chlorine	Decreased fineness modulus	Flowability	Kneading resistance	Carbonation depth	Bonding strength	Rusting ratio of reinforcing bar	Remark
	% by mass	% by mass	ppm	%	sec	A	mm	N/mm ²	%	
2-1	86	3.1	190	70	168	8	2.6	5.4	1	Example
2-2	89	3.9	200	85	167	7	2.3	5.2	1	Example
2-3	91	4.8	210	93	166	7	2.2	5.3	0	Example
1-3	91	4.8	200	98	165	7	2	5.6	0	Example
2-4	89	4.9	200	100	168.0	8	2.4	5.3	1	Example

[0054]

As confirmed from the results of Table 2, when a specific amount of chlorine is contained and fine aggregate including a specific chemical component and having a decreased fineness modulus within a specific range is used, flowability is high, and kneading resistance, carbonation resistance, bonding strength to the reinforcing bar, rusting ratio of the reinforcing bar can be reduced.

[0055]

Experimental Example 3

The same operation as in Experimental Example 1 was carried out except that fine aggregate shown in Table 3 was blended to prepare a quick-hardening repair mortar composition. The results are shown together in Table 3.

[0056]

[Table 3]

No.	CaO	SiO ₂	Chlorine	K ₂ O	SO ₃	Fe ₂ O ₃	Al ₂ O ₃	Flowability	Kneading resistance	Carbonation depth	Bonding strength	Rusting ratio of reinforcing bar	Remark
	% by mass	% by mass	ppm	ppm	ppm	% by mass	% by mass	sec	A	mm	N/mm ²	%	
3-1	90	4.9	190	40	1000	0.6	0.8	161	7	2.2	5.4	1	Example
1-3	91	4.8	200	940	930	0.7	0.8	165	7	2	5.6	0	Example
3-2	89	0.1	160	3000	940	0.2	1.2	161	8	2.4	5.2	1	Example
3-3	90	4.8	210	930	40	1.1	0.3	159	7	2.3	5.2	1	Example
3-4	92	4.2	190	890	3000	0.3	1.2	163.0	7	2.2	5.3	1	Example
3-5	90	4.9	200	930	1000	0.1	0.7	163	8	2.4	5.1	1	Example
3-6	91	5	160	780	900	3	0.5	162	8	2.5	5.4	1	Example
3-7	90	5.1	170	930	900	0.6	0.1	161	7	2.3	5.1	1	Example
3-8	90	4.5	180	890	940	0.5	3	160	8	2.4	5.3	1	Example

[0057]

As confirmed from the results of Table 3, when a specific amount of chlorine is contained and fine aggregate including a specific chemical component is used, flowability is high, and kneading resistance, carbonation resistance, bonding strength to the reinforcing bar, rusting ratio of the reinforcing bar can be reduced.

Industrial Applicability

[0058]

When a specific amount of chlorine is contained and a specific fine aggregate is used in the quick-hardening repair mortar material of the present invention, the quick-hardening repair mortar material that has flowability and workability that is ease of kneading, and higher carbonation resistance, bonding strength to a reinforcing bar, and rust prevention ratio of the reinforcing bar, a quick-hardening repair mortar composition, and a repair method using the same can be provided. Therefore, these can be widely used in techniques for repairing concrete structures used in the fields of civil engineering and construction, for example, water and sewerage, agriculture and fishery, railroad, electric power, road, and construction, gap filling other than the techniques, and fixation of reinforcing bar for reinforcement.

CLAIMS

[Claim 1]

A quick-hardening repair mortar material comprising cement, calcium aluminate, gypsum, polymer emulsion, fibers, and fine aggregate, the quick-hardening repair mortar material having a chlorine amount of 3 ppm or more and 1,800 ppm or less.

[Claim 2]

The quick-hardening repair mortar material according to claim 1, wherein the fine aggregate contains as chemical components 85% by mass or more of CaO and 0.2% by mass or more and 15% by mass or less of SiO₂.

[Claim 3]

The quick-hardening repair mortar material according to claim 1 or 2, wherein the fine aggregate has a decreased fineness modulus in accordance with JIS A 1121 "test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine" of 70% or more and 100% or less.

[Claim 4]

The quick-hardening repair mortar material according to any one of claims 1 to 3, wherein the fine aggregate contains as chemical components 40 ppm or more and 3,000 ppm or less of K₂O, 40 ppm or more and 3,000 ppm or less of SO₃, 0.1% by mass or more and 3.0% by mass or less of Fe₂O₃, and 0.1% by mass or more and 3.0% by mass or less of Al₂O₃.

[Claim 5]

The quick-hardening repair mortar material according to any one of claims 1 to 4, wherein a content ratio of the fine aggregate is 40 parts by mass or more and 300 parts by mass or less relative to 100 parts by mass of the cement.

[Claim 6]

A quick-hardening repair mortar composition comprising the quick-hardening repair mortar material according to any one of claims 1 to 5 and water.

[Claim 7]

A hardening body obtained by using the quick-hardening repair mortar composition according to claim 7.