

DESCRIPTION

Title of Invention

REPAIR MORTAR MATERIAL, REPAIR MORTAR COMPOSITION, AND
HARDENING BODY

Technical Field

[0001]

The present invention relates to a repair mortar material, used in repair and reinforcement work of a concrete structure in the civil engineering and construction fields, a repair mortar composition, and a hardening body.

Background Art

[0002]

A concrete structure is progressively deteriorated through actions, such as brine damage, neutralization, freezing and thawing, and chemical corrosion, which bring about a concern of cracks and blister on the surface thereof. Countermeasures thereto include repair work of confirming the deteriorated part by a hammering test or the like, removing the deteriorated part with an electric pick, an air pick, a water jet, or the like, and then filling a fresh repair material therein.

In the small scale repair work with a small repair section surface, the section surface is repaired by troweling kneaded polymer cement mortar in many cases (see, for example, PTLs 1 and 2).

[0003]

In the case of repairing by troweling, or the like, the mortar used is demanded to be a material having good workability, for example, rapid curability, kneadability, and thickenability. Therefore, a material blended with inorganic fine powder, such as fly ash and silica fume, as shown in PTLs 1 and 2, and a material blended with a cellulose ether compound have been used for the purpose of imparting suitable viscosity and dripping resistance to the mortar (see, for example, NPL 1 and PTLs 3 to 6). The use of the cellulose ether compound increases the viscosity and improves the water retentivity, but increases the resistance in kneading to increase the load on the mixer and the workers, and causes attachment to the trowel in plastering, resulting in problems in

thickenability.

[0004]

The polymer cement mortar densifies the cured structure through mixing of a polymer emulsion, and thereby suppresses permeation of carbon dioxide gas, chloride ion, and water, so as to impart durability, but cannot completely block the permeation. In particular, the structure may shrink through dissipation of water in the uncured state, and cracks may occur in the initial stage or after several months in some cases. For solving the problem, a drying shrinkage reducing agent has been blended (see, for example, PTLs 7 and 8). However, the drying shrinkage reducing agent may delay the setting to cause initial cracks through dissipation of water in the uncured state, and thereby the durability may be deteriorated in some cases. The delay in setting may generally occur similarly with the cellulose ether compound.

[0005]

Furthermore, there are a problem of a low fluidity at a high temperature, a problem of deteriorated workability due to the high resistance in kneading, and a danger of occurrence of cracks in the hardening body and decrease in adhesion capability to the structure caused by corrosion of a reinforcing steel bar due to brine damage. Therefore, there is a demand of the retention of a high fluidity at a high temperature and the low kneading resistance, which provide a higher adhesion strength to a reinforcing steel bar, resulting in securement of integration with the structure and the durability thereof.

Citation List

Patent Literatures

[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 Suiyosei Polymer no Oyo to Shijo (New Applications and Markets of Water Soluble Polymers), edited by NAGATOMO Shinji, CMC Publishing Co., Ltd., pp. 173-192, 1988

Summary of Invention

Technical Problem

[0008]

An object of the present invention is to provide a repair mortar material that has a high fluidity and a low kneading resistance, and can further enhance the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the rust inhibiting rate of a reinforcing steel bar, by containing a particular amount of chlorine and combining a particular material and a particular fine aggregate, a repair mortar composition, and a hardening body.

Solution to Problem

[0009]

The present invention has been made for solving the problem, and as a result of various efforts performed by the present inventors for solving the problem, it has been found that a repair mortar material that contains a particular amount of chlorine and a combination of a particular material and a particular fine aggregate can has a high the fluidity, can reduce the kneading resistance, and can further enhance the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the rust inhibiting rate of a reinforcing steel bar, thereby enhancing the durability, and thus the present invention has been completed. The substance of the present invention is as follows.

[1] A repair mortar material containing cement, an expanding material, a polymer emulsion, fibers, and a fine aggregate, the repair mortar material having an amount of chlorine of 3 ppm or more and 1,800 ppm or less.

[2] The repair mortar material according to the item [1], wherein the expanding material contains ternesite, and has a content of the ternesite of 0.05 part by mass or more and 20 parts by mass or less per 100 parts by mass of the expanding material.

[3] The repair mortar material according to the item [1] or [2], wherein

the fine aggregate has a chemical composition having a proportion of CaO of 85% by mass or more and a proportion of SiO₂ of 0.2% by mass or more and 15% by mass or less.

[4] The repair mortar material according to any one of the items [1] to [3], wherein the fine aggregate has a reduction in fineness modulus by the "test for resistance to abrasion of coarse aggregate by the Los Angeles machine" according to JIS A1121 of 70% or more and 100% or less.

[5] The repair mortar material according to any one of the items [1] to [4], wherein the fine aggregate has a chemical composition having a proportion of K₂O of 40 ppm or more and 3,000 ppm or less, a proportion of SO₃ of 40 ppm or more and 3,000 ppm or less, a proportion of Fe₂O₃ of 0.1% by mass or more and 3.0% by mass or less, and a proportion of Al₂O₃ of 0.1% by mass or more and 3.0% by mass or less.

[6] The repair mortar material according to any one of the items [1] to [5], wherein the repair mortar material has a content ratio of the fine aggregate of 40 parts by mass or more and 300 parts by mass or less per 100 parts by mass of the cement.

[7] A repair mortar composition containing the repair mortar material according to any one of the items [1] to [6] and water.

[8] A hardening body containing the repair mortar composition according to the item [7].

Advantageous Effects of Invention

[0010]

The present invention can provide a repair mortar material that has a high fluidity and a low kneading resistance, and can further enhance the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the rust inhibiting rate of a reinforcing steel bar, by containing a particular amount of chlorine and combining a particular material and a particular fine aggregate, a repair mortar composition, and a hardening body.

Description of Embodiments

[0011]

The present invention will be described in detail below.

The parts and percentages in the description herein each are based on mass

unless otherwise indicated.

The repair mortar composition referred in the description herein is a comprehensive term for a paste containing no coarse aggregate and mortar containing a fine aggregate.

[0012]

The repair mortar material of the present invention contains cement, an expanding material, a polymer emulsion, fibers, and a fine aggregate, and has an amount of chlorine of 3 ppm or more and 1,800 ppm or less.

In the repair mortar material of the present invention, the amount of chlorine contained is focused, and it has been found that the amount of chlorine influences the adhesion strength of the repair mortar material and a reinforcing steel bar. Specifically, in the case where the amount of chlorine contained in the repair mortar material is less than 3 ppm, the adhesion strength to a reinforcing steel bar is lowered. In the case where the amount of chlorine contained in the repair mortar material exceeds 1,800 ppm, the rust inhibiting effect is lowered.

The amount of chlorine contained in the repair mortar material is preferably 30 ppm or more, more preferably 40 ppm or more, further preferably 50 ppm or more, still further preferably 100 ppm or more, and particularly preferably 130 ppm or more, from the standpoint of enhancing the adhesion strength to a reinforcing steel bar. The amount of chlorine contained in the repair mortar material is necessarily 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, from the standpoint of enhancing the rust inhibiting effect of a reinforcing steel bar for enhancing the durability.

[0013]

The amount of chlorine contained in the repair mortar material can be regulated, for example, by adding an admixture containing chlorine in the production of the repair mortar material. The amount of chlorine can be measured by the method described in the examples described later.

[0014]

The cement used in the present invention is not particularly limited, examples of which include various types of cement, such as ordinary, high early strength, ultrahigh early strength, low heat, and moderate heat, various types of mixed cement obtained by mixing blast furnace slag, fly ash, silica fume, or the like to the above cement, environment friendly cement (eco-cement) produced from

municipal waste incineration ash and sewage sludge incineration ash as a raw material, and commercially available fine particle cement, and various types of cement and various types of mixed cement having been micronized may also be used. Cement obtained by increasing or decreasing the amount of the component that is ordinarily used in cement (such as gypsum) may also be used.

In the present invention, ordinary Portland cement or high early strength Portland cement is preferably selected from the standpoint of the high fluidity, the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the rust inhibition thereof.

[0015]

The cement used in the present invention preferably has a Blaine specific surface area value (which may be hereinafter referred to as a Blaine value) of 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, from the standpoint of the production cost and the strength exhibiting capability.

The Blaine specific surface area value is obtained according to JIS R5201 (physical testing methods for cement).

[0016]

The expanding material used in the present invention is not particularly limited, and any material that can form an expansive hydrate to suppress the bleeding may be used.

Expanding materials containing free lime, free magnesia, calcium ferrite, an ettringite-based material, a lime-based material, or an ettringite-lime-based complex material have been known, and an expanding material containing free lime is preferred from the standpoint of the long-term stability, while not particularly limited. Examples of the expanding material containing free lime include a free lime-anhydrous gypsum-based material, a free lime-hydraulic compound-based material, and a free lime-hydraulic compound-anhydrous gypsum-based material.

The expanding material used in the present invention preferably contains ternesite. Ternesite is a mineral represented by $5\text{CaO} \cdot 2\text{SiO}_2 \cdot \text{SO}_3$, and accelerates the hydraulic reaction. Furthermore, ternesite substantially does not engage in the reaction, and therefore is expected to function like a filler to improve the fluidity retaining capability. Accordingly, the effect of retaining fluidity can be

held even at a high temperature.

The content of ternesite is preferably 0.05 part by mass or more and 20 parts by mass or less, more preferably 0.1 part by mass or more and 18 parts by mass or less, and further preferably 0.5 part by mass or more and 15 parts by mass or less, per 100 parts by mass of the expanding material. Ternesite contained in an amount within the range can improve both the curing acceleration and the fluidity retaining capability.

In the present invention, a free lime-hydraulic compound-anhydrous gypsum-based material is preferably used, and the material having a free lime content exceeding 40% is particularly preferred, due to the good expanding capability thereof.

Examples of the hydraulic compound herein include one kind or two or more kinds of hauyne, calcium ferrite, calcium aluminoferrite, calcium silicate, calcium aluminate. In the present invention, an expanding material and a non-explosive demolition agent that are commercially available may be used as the expanding material.

The expanding material and the non-explosive demolition agent are available from various companies, and examples thereof include "Denka CSA #20" and "Denka Power CSA", produced by Denka Co., Ltd., "Expan", "Hyper Expan", "N-EX", and "Bristar", produced by Taiheiyo Materials Corporation, and crushed materials thereof.

[0017]

The grain size of the expanding material used in the present invention is not particularly limited, and is, in terms of Blaine value, preferably 2,000 cm²/g or more and 25,000 cm²/g or less, more preferably 2,200 cm²/g or more and 15,000 cm²/g or less, and further preferably 2,400 cm²/g or more and 10,000 cm²/g or less. In the case where the Blaine value of the expanding material is the lower limit value or more, the bleeding can be suppressed. In the case where the Blaine value of the expanding material is the upper limit value or less, the sufficient expansion capability can be obtained.

[0018]

The content ratio of the expanding material used in the present invention is preferably 0.5 part by mass or more and 20 parts by mass or less, more preferably 1.0 part by mass or more and 18 parts by mass or less, and further preferably 2 parts by mass or more and 15 parts by mass or less, per 100 parts by mass of the

cement. In the case where the content ratio of the expanding material is the lower limit value or more, the effect of suppressing cracks can be easily obtained. In the case where the content ratio of the expanding material is the upper limit value or less, the strength exhibiting capability can be improved. In the case where the content ratio of the expanding material is in the range, the repair mortar material satisfying the effects of the present invention, i.e., the repair mortar material that has a high fluidity, the kneading resistance, and excellent brine damage resistance, adhesion strength to a reinforcing steel bar, and rust inhibition thereof, can be easily obtained.

[0019]

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

Examples of the form of the polymer include a redispersible powder type and a liquid type, and the polymer is used for improving the adhesion to the ground and for enhancing the durability of mortar.

[0020]

The amount of the polymer emulsion used is generally, in terms of solid content, preferably 1 to 15 parts by mass, and more preferably 3 to 10 parts by mass, per 100 parts by mass of the cement. In the case where the amount of the polymer emulsion used is in the range, the kneading resistance can be reduced, and the brine damage resistance and the adhesion strength can be enhanced.

[0021]

The fibers used in the present invention are used for improving the thickenability and the crack resistance.

The kind of the fibers is not particularly limited, and examples thereof include polymer-based fibers, such as vinylon fibers, propylene fibers, acrylic fibers, nylon fibers, and aramid fibers, and inorganic-based fibers, such as steel fibers, glass fibers, carbon fibers, and fibers obtained by melt-spinning a rock, such as basaltic rock.

[0022]

The amount of the fibers used is preferably 0.02 to 1.5 parts by mass, and more preferably 0.05 to 1.0 part by mass, per 100 parts by mass of the repair mortar material. In the case where the amount of the fibers used is 0.02 part by mass or more, the effect of improving the dripping resistance can be sufficiently exerted. In the case where the amount of the fibers used is 1.5 parts by mass or less, the kneading resistance can be improved.

The length of the fibers is preferably 15 mm or less, more preferably 12 mm or less, and further preferably 10 mm or less, from the standpoint of the appearance of the troweled surface.

[0023]

The chemical composition of the fine aggregate used in the present invention preferably has a proportion of CaO of 85% by mass or more and a proportion of SiO₂ of 0.2% by mass or more and 15% by mass or less. In the case where the chemical composition of the fine aggregate has a proportion of CaO and a proportion of SiO₂ within the ranges, the repair mortar material that has high fluidity and brine damage resistance, and excellent adhesion strength to a reinforcing steel bar and rust inhibition thereof can be obtained.

The proportion 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 proportion of CaO is not particularly limited, and is preferably 99% by mass or less, and more preferably 98.5% by mass or less.

The proportion 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.

For allowing the chemical composition of the fine aggregate within the aforementioned range and the range described later, the fine aggregate may be prepared by mixing silica sand, calcite, scapolite as a metamorphic rock, quartz and potassium feldspar as igneous rocks, and the like. The chemical composition is regulated to the range of the present invention by mixing the rocks under confirmation by fluorescent X-ray diffraction. The chemical composition of the fine aggregate used in the present invention is calculated as oxide conversion.

[0024]

The fine aggregate used in the present invention preferably has a chemical composition containing K₂O, SO₃, Fe₂O₃, and Al₂O₃. In the case where the fine aggregate contains K₂O, SO₃, Fe₂O₃, and Al₂O₃, high fluidity, brine damage

resistance, adhesion strength to a reinforcing steel bar and rust inhibition thereof can be obtained.

The proportion 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 further preferably 70 ppm or more and 2,000 ppm or less.

The proportion 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 further preferably 70 ppm or more and 2,000 ppm or less.

The proportion 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 proportion 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.

[0025]

The fine aggregate used in the present invention preferably has a reduction in fineness modulus by the "test for resistance to abrasion of coarse aggregate by the Los Angeles machine" according to JIS A1121 of 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 further preferably 85% or more and 97% or less. In the case where the reduction in fineness modulus of the fine aggregate is the lower limit value or more, the adhesion force to a reinforcing steel bar can be enhanced. In the case where the reduction in fineness modulus of the fine aggregate is the upper limit value or less, the brine damage resistance can be enhanced. In the description herein, the "fineness modulus of the fine aggregate" is a value that is obtained from the result of sieving, and is an index showing an approximate value of the size of the fine aggregate. In the description herein, the "reduction in fineness modulus of the fine aggregate" means the reduction rate of the fineness modulus after the test in the comparison between the fineness modulus before the test for resistance to abrasion of coarse aggregate by the Los Angeles machine and the fineness modulus after the test.

For allowing the reduction in fineness modulus of the fine aggregate within the aforementioned range, the fine aggregate may be prepared by mixing silica

sand, calcite, scapolite as a metamorphic rock, quartz and potassium feldspar as igneous rocks, and the like. The reduction in fineness modulus of the fine aggregate is regulated to the range of the present invention by mixing the rocks under confirmation by the test for resistance to abrasion of coarse aggregate by the Los Angeles machine.

The production region and the origin of the fine aggregate are not particularly limited, as far as the reduction in fineness modulus of the fine aggregate is in the range.

[0026]

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, per 100 parts by mass of the cement. In the case where the content ratio of the fine aggregate is the lower limit value or more, the heat generation amount can be reduced to suppress the shrinkage, thereby suppressing cracks from occurring. In the case where the content ratio of the fine aggregate is the upper limit value or less, the repair mortar material that has high fluidity and brine damage resistance, and excellent adhesion strength to a reinforcing steel bar and rust inhibition thereof can be obtained.

[0027]

The repair mortar material of the present invention may contain siliceous fine powder along with the cement, the expanding material, the polymer emulsion, the fibers, and the fine aggregate, from the standpoint of improving the strength exhibiting capability, enhancing the acid resistance, securing the usable time, and furthermore improving the dimensional stability.

[0028]

Examples of the siliceous fine powder include a latent hydraulic substance, such as granulated blast furnace slag, and a pozzolanic substance, such as fly ash and silica fume, and among these, silica fume is preferred.

The kind of the silica fume is not limited, and silica fume containing ZrO_2 in an amount of 10% or less as an impurity, and acidic silica fume are preferably used from the standpoint of the fluidity. The acidic silica fume means silica fume that provides a supernatant showing acidity of pH 5.0 or less in adding 1 g of the silica fume in 100 cc of pure water, followed by stirring.

[0029]

The powder fineness of the siliceous fine powder is not particularly limited, and is generally in a range of 3,000 cm²/g or more and 9,000 cm²/g or less in terms of Blaine value for granulated blast furnace slag and fly ash, and in a range of 20,000 cm²/g or more and 300,000 cm²/g or less in terms of BET specific surface area for silica fume.

[0030]

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, per 100 parts by mass of the cement. In the case where the content ratio of the siliceous fine powder is the lower limit value or more, the strength exhibiting capability can be improved, the acid resistance can be enhanced, the usable time can be secured, and the dimensional stability can be improved. In the case where the content ratio of the siliceous fine powder is the upper limit value or less, the fluidity can be enhanced, the adhesion force to a reinforcing steel bar and the rust inhibition thereof can be enhanced.

[0031]

In the present invention, an anti-foaming agent may be used in such a range that does not adversely affect the performance. The anti-foaming agent is used for the purpose of suppressing the amount of air entrained in kneading.

The kind of the anti-foaming agent is not particularly limited, as far as the strength characteristics of the cured mortar are not significantly impaired, and any one in a liquid form or a powder form may be used. Examples thereof include a polyether-based anti-foaming agent, a polyhydric alcohol-based anti-foaming agent, such as an ester and an alkyl ether of a polyhydric alcohol, an alkyl phosphate-based anti-foaming agent, and a silicone-based anti-foaming agent.

[0032]

The amount of the anti-foaming agent used is preferably 0.002 to 0.5 part by mass, and more preferably 0.01 to 0.4 part by mass, per 100 parts by mass of the cement. In the case where the amount of the anti-foaming agent used is the lower limit value or more, the anti-foaming effect can be sufficiently exerted. In the case where the amount of the anti-foaming agent used is the upper limit value or less, the decrease of the adhesion strength to a reinforcing steel bar can be suppressed.

[0033]

In the present invention one kind or two or more kinds of a setting retarder, a gas foaming substance, ~~an expanding material~~, a water reducing agent, a setting modifier, an air entraining agent, a rust inhibitor, a water repellent, an antibacterial agent, a colorant, an anti-freezing agent, an admixture material, such as limestone fine powder, air-cooled blast furnace slag fine powder, sewage sludge incineration ash and molten slug thereof, municipal waste incineration ash and molten slug thereof, and pulp sludge incineration ash, a thickener, a shrinkage reducer, a polymer, a clay mineral, such as bentonite and sepiolite, and an anion exchanger, such as hydrotalcite, may be used in such a range that does not adversely affect the performance and substantially does not impair the object of the present invention.

[0034]

The repair mortar material of the present invention is not particularly limited in mixing method of the materials, and the materials may be mixed in the execution thereof, or a part or the whole thereof may be mixed in advance.

The mixing device used may be any device, and for example, a tilting mixer, an omni mixer, a Henschel mixer, a V-type mixer, and a Nauta Mixer may be used.

[0035]

The repair mortar composition of the present invention contains the repair mortar material of the present invention described above and water, and obtained by kneading the repair mortar material and water.

The amount of water to be kneaded in the present invention is not particularly limited since the amount thereof vary depending on the object and purpose in use and the content ratios of the materials, and 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, per 100 parts by mass of the repair mortar material. In the case where the amount of water to be kneaded is the lower limit value or more, the kneading can be easily performed, and the workability, i.e., the thickenability, can be enhanced. In the case where the amount of water to be kneaded is the upper limit value or less, the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the rust inhibiting rate of a reinforcing steel bar can be easily secured.

[0036]

Examples of the repairing method using the repair mortar material of the

present invention include a method of kneading with a prescribed amount of water and then troweling on the repair part with a trowel, and in some cases, a method of delivering the kneaded mortar under pressure with a pump that does not impair the work, and spraying on the repair part with compressed air, followed by finishing with a trowel. The kneading method may be a method of placing the materials in a vessel, such as a bucket canister, and kneading with a hand mixer, and a method of kneading with a pan mixer. The repair mortar composition of the present invention is kneaded and troweled to form a hardening body.

A specific example of the repairing method is as follows. The deteriorated part of concrete is removed with a water jet, and then a primer is coated thereon. Subsequently, the kneaded mortar is troweled with a trowel, or coated by spraying. For a wall surface and a ceiling surface, a repair thickness of approximately 30 mm can be achieved through a single troweling operation, and therefore the surface thereof is finished with a trowel. For a repair thickness exceeding 30 mm, the repairing operation is performed by dividing into multiple layers. In this case, the placing joint surface is not finished smoothly with a trowel, but is roughly finished to secure the adhesion force. The timing of the jointing work may vary depending on the ambient temperature, and the like, and it suffices that the jointing work is performed at the time when the mortar troweled in advance is cured to such a state that the surface thereof does not dent with a finger. Finally, the surface is finished by smoothing with a trowel. In the case of more careful work, it is preferred that a curing sheet, a curing agent, or the like is used for preventing dryness.

Examples

[0037]

The present invention will be further described with reference to experimental examples of the present invention shown below, but the present invention is not limited thereto.

[0038]

[Experimental Example 1]

A repair mortar material was prepared by regulating 10 parts by mass of an expanding material, 5 parts by mass of a polymer emulsion, 0.6 part by mass of fibers, and 120 parts by mass of a fine aggregate contained in 100 parts by mass of cement. Subsequently, a chlorine-containing admixture (material name: sodium

chloride) was mixed therein to prepare a repair mortar material.

23 parts by mass of water per 100 parts by mass of the resulting repair mortar material were kneaded to prepare a repair mortar composition.

The repair mortar composition thus prepared was measured for the chlorine concentration, the fluidity, the kneading resistance, the chloride ion submergence depth, the adhesion strength, and the rusting rate of a reinforcing steel bar. The results are shown in Table 1.

[0039]

<Materials Used>

- Cement: Test cement (Commercially available pure chemicals were used as the preparation materials of the cement factory and for regulating the chemical composition, and anhydrous gypsum as a pure chemical was used for regulating the SO₃ amount) having a chlorine amount of 1.5 ppm and a Blaine value of 3,450 cm²/g

- Expanding material: The expanding material was produced in such a manner that a CaO material, an Al₂O₃ material, an SiO₂ material, and a CaSO₄ material were blended, mixed, and pulverized, and then fired at 1,200°C to synthesize a clinker, which was pulverized with a ball mill to a Blaine specific surface area of 3,000 cm²/g. The mineral composition of ternesite was obtained through calculation based on the chemical composition obtained by fluorescent X-ray and the identification result of the powder X-ray diffraction. The content of ternesite per 100 parts by mass of the expanding material is shown in Table 1.

- Polymer emulsion: A polyacrylate ester redispersible resin, commercially available product, having a water content of 0.8% and a density of 0.5 g/mL

- Fibers: Vinyon fibers having a fiber length of 6 mm, a fineness of 6.6 dtex, a dry strength of 1,850 N/mm², and a dry elongation of 6.0%

- Water: Tap water

- Fine aggregate: The test was performed by using the composition of the fine aggregate shown in Table 1. The chemical composition of the fine aggregate was measured by fluorescent X-ray diffraction. For preparing the chemical composition, silica sand (from Aichi prefecture), calcite (CaCO₃), scapolite ((Na,Ca,K)₄Al₄Si₉O₂₄(Cl,CO₃,SO₄)) as a metamorphic rock, quartz (SiO₂) and potassium feldspar (KAlSi₃O₈) as igneous rocks were mixed to prepare the chemical composition.

[0040]

<Measured Items>

- Chlorine concentration: The repair mortar composition thus prepared was measured for the chlorine concentration according to JIS R5202.

- Fluidity: The flow value was measured according to JIS R5201 under an environment of 20°C.

- Kneading resistance: The repair mortar composition was kneaded with a hand mixer for kneading mortar under an environment of 20°C for 90 seconds, and the electric current value at this time was measured with a clamp meter, and the maximum value was designated as the index of kneading resistance.

- Chloride ion submergence depth: The material subjected to underwater curing at 20°C until a material age of 28 days according to JIS A1171 was immersed in a brine solution defined in JIS A6205, Appendix 1 (Brine immersion test method of reinforcing steel bar), 3.2.1 (Brine solution) at 20°C, and then taken out therefrom after 28 days. The specimen after immersing in the brine solution was fractured into two pieces, a 0.1% fluorescein sodium aqueous solution and a 0.1 mol/L silver nitrate solution were sprayed on the cross sectional surface thereof, and the part emitting fluorescent light was designated as the chloride ion submergence depth.

- Adhesion strength: The adhesion strength to a reinforcing steel bar was obtained by withdrawing a round bar steel having a diameter of 19 mm embedded to a depth of 16 cm. The material was cured by sealed curing at 20°C, and the test was performed at a material age of 28 days.

- Rusting rate of reinforcing steel bar: The ultrarapid hardening mortar filled on a round bar steel having a diameter of 19 mm embedded to a depth of 18 cm to a covering depth of 10 mm was subjected to underwater curing at 20°C until a material age of 28 days, and then subjected to accelerated neutralization in an environment of 30°C, a relative humidity of 60%, and a carbon dioxide gas concentration of 5% for 12 weeks. During the accelerated neutralization test, the test specimen was taken out every 3 weeks and immersed in water under an environment of 20°C for 1 day to perform the accelerated neutralization test. After completing the test, the round steel bar was taken out, and after removing rust with a 10% diammonium citrate solution, measured for the weight (m_2) of the round steel bar after the test, and the rusting rate of the reinforcing steel bar was calculated based on the change from the weight (m_1) of the round steel bar before the test according to the following expression.

Rusting rate of reinforcing steel bar (%) = $((m_1 - m_2)/m_1) \times 100$

[0041]

Table 1

No.	CaO		SiO ₂		Chlorine	Terresite	Fluidity		Kneading resistance	Chloride ion submergence depth	Adhesion strength	Rusting rate of reinforcing steel bar	Note
	% by mass		% by mass				Immediate	After 30 min					
1-1	91		4.8		1	5	sec	sec	A	mm	N/mm ²	%	Comparative Example
1-2	91		4.8		3	5	165	159	8	3.3	4.9	2	
1-3	91		4.8		200	5	168	164	6	2.8	5.5	0	
1-4	91		4.8		1800	5	160	155	7	3	4.9	1	
1-5	91		4.8		2200	5	140	129	12	4.1	3.3	9	Comparative Example
1-6	10		83		200	5	158	154	9	3.6	4.5	5	Example
1-7	85		4.9		210	5	163	158	7	3.3	4.9	1	Example
1-8	92		0.2		210	5	164	157	7	3.3	5	1	Example
1-9	91		4.8		190	5	163	159	6	2.8	5.5	0	Example
1-10	90		15		200	5	165	160	7	3.5	5.2	1	Example
1-11	91		4.9		190	0.1	160	153	7	3.1	5.2	2	Example
1-12	90		4.8		190	20	162	160	6	3.3	5.2	2	Example

[0042]

It was confirmed from the results in Table 1 that the use of the particular amount of chlorine contained and the fine aggregate having the particular chemical composition achieved the high fluidity, the kneading resistance, the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the suppression of rusting rate of a reinforcing steel bar.

[0043]

[Experimental Example 2]

The same procedures as in Experimental Example 1 were performed except that the fine aggregates shown in Table 2 were blended to prepare repair mortar compositions. The results are shown in Table 2.

The test for resistance to abrasion of fine aggregate by the Los Angeles machine was performed in the following manner. 5 kg of the fine aggregate and 6 iron balls were placed in the Los Angeles machine. The iron balls had an average diameter of approximately 46.8 mm and a mass of 390 to 445 g per one ball. Subsequently, the Los Angeles machine was operated by 500 rotations (30 rpm). Subsequently, the fine aggregate taken out from the Los Angeles machine was sieved with metal meshes of 5 mm, 2.5 mm, 1.2 mm, 0.6 mm, 0.3 mm, and 0.15 mm. The fineness modulus (R_1) of the fine aggregate before subjecting to the Los Angeles machine and the fineness modulus (R_2) of the fine aggregate after subjecting to the Los Angeles machine were compared, and the reduction in fineness modulus after the test was calculated according to the following expression.

$$\text{Reduction in fineness modulus} = R_2/R_1$$

[0044]

Table 2

No.	CaO		SiO ₂		Chlorine	reduction in fineness modulus	Fluidity		Kneading resistance	Chloride ion submergence depth	Adhesion strength	Rusting rate of reinforcing steel bar	Note
	% by mass	% by mass	% by mass	% by mass			Immediate	After 30 min					
2-1	86		3.1		190	70	sec 169	sec 165	A 7	mm 3.5	N/mm ² 4.3	% 2	Example
2-2	89		3.9		200	85	167	163	7	3.3	4.2	1	Example
2-3	91		4.8		210	93	169	164	6	3.1	5.2	0	Example
1-3	91		4.8		200	98	163	159	6	2.8	5.5	0	Example
2-4	89		4.9		200	100	168.0	163.0	7.0	3.3	4.3	2	Example

[0045]

It was confirmed from the results in Table 2 that the use of the particular amount of chlorine contained and the fine aggregate having the particular chemical composition and the reduction in fineness modulus within the particular range achieved the high fluidity, the kneading resistance, the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the suppression of rusting rate of a reinforcing steel bar.

[0046]

[Experimental Example 3]

The same procedures as in Experimental Example 1 were performed except that the fine aggregates shown in Table 3 were blended to prepare repair mortar compositions. The results are shown in Table 3.

[0047]

Table 3

No.	CaO % by mass	SiO ₂ % by mass	Chlorine ppm	K ₂ O ppm	SO ₃ ppm	Fe ₂ O ₃ % by mass	Al ₂ O ₃ % by mass	Fluidity		Kneading resistance	Chloride ion submergence depth	Adhesion strength N/mm ²	Rusting rate of reinforcing steel bar %	Note
								Immediate sec	After 30 min sec					
3-1	90	4.9	190	40	1000	0.6	0.8	162	158	7	3.4	5.1	2	Example
1-3	91	4.8	200	940	930	0.7	0.8	163	159	6	2.8	5.5	0	Example
3-2	89	0.1	160	3000	940	0.2	1.2	160	155	7	3.4	4.9	1	Example
3-3	90	4.8	210	930	40	1.1	0.3	161	157	7	3.2	5.2	2	Example
3-4	92	4.2	190	890	3000	0.3	1.2	163	157	7.0	3.3	4.9	1	Example
3-5	90	4.9	200	930	1000	0.1	0.7	162	155	7	3.4	5.1	2	Example
3-6	91	5	160	780	900	3	0.5	162	155	7	3.6	5.1	2	Example
3-7	90	5.1	170	930	900	0.6	0.1	163	156	6	3.3	4.8	1	Example
3-8	90	4.5	180	890	940	0.5	3	160	156	8	3.5	4.9	1	Example

[0048]

It was confirmed from the results in Table 3 that the use of the particular amount of chlorine contained and the fine aggregate having the particular chemical composition achieved the high fluidity, the kneading resistance, the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the suppression of rusting rate of a reinforcing steel bar.

Industrial Applicability

[0049]

The repair mortar material of the present invention contains the particular amount of chlorine and uses the particular fine aggregate, and thereby can further enhance the workability, i.e., the fluidity and the kneadability, and also the brine damage resistance, the adhesion strength to a reinforcing steel bar, and the suppression of rust inhibiting rate of a reinforcing steel bar, and the repair mortar material, the repair mortar composition, and the repairing method thereof can be provided. Therefore, the repair mortar material can be widely applied to the civil engineering and construction fields, including repairing work of concrete structures used in the water supply and sewerage systems, the agricultural and fishery industries, the railroads, the electric power systems, the roads, and the constructions, the miscellaneous gap filling, the adhesion to a reinforcing steel bar, and the like.

CLAIMS

[Claim 1]

A repair mortar material comprising cement, an expanding material, a polymer emulsion, fibers, and a fine aggregate, the repair mortar material having an amount of chlorine of 3 ppm or more and 1,800 ppm or less.

[Claim 2]

The repair mortar material according to claim 1, wherein the expanding material contains ternesite, and has a content of the ternesite of 0.05 part by mass or more and 20 parts by mass or less per 100 parts by mass of the expanding material.

[Claim 3]

The repair mortar material according to claim 1 or 2, wherein the fine aggregate has a chemical composition having a proportion of CaO of 85% by mass or more and a proportion of SiO₂ of 0.2% by mass or more and 15% by mass or less.

[Claim 4]

The repair mortar material according to any one of claims 1 to 3, wherein the fine aggregate has a reduction in fineness modulus by the "test for resistance to abrasion of coarse aggregate by the Los Angeles machine" according to JIS A1121 of 70% or more and 100% or less.

[Claim 5]

The repair mortar material according to any one of claims 1 to 4, wherein the fine aggregate has a chemical composition having a proportion of K₂O of 40 ppm or more and 3,000 ppm or less, a proportion of SO₃ of 40 ppm or more and 3,000 ppm or less, a proportion of Fe₂O₃ of 0.1% by mass or more and 3.0% by mass or less, and a proportion of Al₂O₃ of 0.1% by mass or more and 3.0% by mass or less.

[Claim 6]

The repair mortar material according to any one of claims 1 to 5, wherein the repair mortar material has a content ratio of the fine aggregate of 40 parts by mass or more and 300 parts by mass or less per 100 parts by mass of the cement.

[Claim 7]

A repair mortar composition comprising the repair mortar material according to any one of claims 1 to 6 and water.

[Claim 8]

A hardening body comprising the repair mortar composition according to

claim 7.