

Description

Title of Invention: CEMENT ADMIXTURE, CEMENT COMPOSITION
AND PRODUCTION METHOD THEREFOR

Technical Field

[0001]

The present invention relates mainly to a cement admixture and a cement composition to be used in civil engineering and construction industries.

Background Art

[0002]

In recent years, in civil engineering and construction fields, there has been raised the demand for improvement of durability of concrete structures.

[0003]

As one of deterioration causes of concrete structures, there is salt damage in which reinforcements corrode due to the presence of chloride ions; as suppressing means thereof, there is a method of imparting the chloride ion penetration resistance to concrete structures.

[0004]

As a method of suppressing chloride ion penetration into hardened concrete interiors and imparting the chloride ion penetration resistance, a method of lowering

the water/cement ratio is known (see Non Patent Literature 1). However, in some cases, the method of lowering the water/cement ratio not only impairs workability but also fails to be a thorough measure.

[0005]

Further, for the purpose of imparting the high-early-strength property to a cement concrete, preventing corrosion of a reinforcement, and the like, a method of using a cement admixture containing a micropowder containing $\text{CaO} \cdot 2\text{Al}_2\text{O}_3$ and gypsum as main components and having a Blaine specific surface area value of 8,000 cm^2/g or more is proposed (see Patent Literature 1).

[0006]

Furthermore, a method of using a cement admixture which contains a calcium aluminate having a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.3 to 0.7 and a Blaine specific surface area value of 2000 to 7000 cm^2/g , brings about excellent chloride ion penetration resistance, and suppresses temperature cracking of mass concrete is proposed (see Patent Literature 2). Further, a cement admixture containing a calcium ferroaluminate compound having a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a Fe_2O_3 content of 0.5 to 20% by mass is proposed (see Patent Literature 3).

[0007]

On the other hand, for the purpose of rust prevention of reinforcements, a method of adding a

nitrite salt or the like is also proposed (see Patent Literature 4 and Patent Literature 5).

Citation List

Patent Literature

[0008]

Patent Literature 1: Japanese Patent Laid-open No. 47-035020

Patent Literature 2: Japanese Patent Laid-open No. 2005-104828

Patent Literature 3: Japanese Patent No. 5688073

Patent Literature 4: Japanese Patent Laid-open No. 53-003423

Patent Literature 5: Japanese Patent Laid-open No. 01-103970

Non Patent Literature

[0009]

Non Patent Literature 1: "Concrete Structure Durability Series, Salt Damage (I)" (in Japanese), Gihodo Shuppan Co., Ltd., Kishitani K., Nishizawa N., et al. (eds.), pp.34-37, May 1986

Summary of Invention

Technical Problem

[0010]

There are provided a cement admixture, a cement composition and a production method thereof, which impart

an excellent rustproofing effect on reinforcements inside hardened cement concretes, have a shielding effect against penetration of chloride ions from the outside, and exhibit little leaching of Ca ions from the hardened cement concretes and enable suppression of porosification.

Solution to Problem

[0011]

The present invention provides (1) a cement admixture comprising a calcium boron aluminate having a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a B_2O_3 content of 0.05 to 10% by mass; (2) the cement admixture according to (1) having a fineness of the calcium boron aluminate of 2,000 to 7,000 cm^2/g in terms of a Blaine specific surface area value; (3) a cement composition comprising a cement and the cement admixture according to (1) or (2); and (4) a method for producing a cement composition, the method comprising mixing a calcium boron aluminate and a cement, the calcium boron aluminate being obtained by mixing a raw material comprising calcia, a raw material comprising alumina and a raw material comprising boron so as to provide a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a B_2O_3 content of 0.05 to 10% by mass, firing the resulting mixture at 1,400°C or more, and thereafter crushing the mixture so as to provide a Blaine specific surface area value of 2000 to 7000 cm^2/g .

Advantageous Effects of Invention

[0012]

Use of the cement admixture of the present invention brings about an excellent rustproofing effect, a shielding effect of chloride ions penetrating from the outside, also an effect of being capable of suppressing porosification due to little leaching of Ca ions from hardened cement concretes, and the like.

Brief Description of Drawings

[0013]

[Figure 1] Figure 1 shows X-ray diffraction spectra of calcium boron aluminate samples and a control thereof.

Description of Embodiments

[0014]

Hereinafter, the present invention will be described in detail. Here, parts and % in the present description are indicated in terms of mass unless otherwise specified. Further, cement concrete used in the present description is a general term of cement paste, cement mortar and concrete. Further in the present description, the numerical value range includes the upper limit value and the lower limit value unless otherwise specified.

[0015]

The calcium boron aluminate (hereinafter, also abbreviated to CBA) to be used in the present invention is a general term of compounds containing CaO , Al_2O_3 and B_2O_3 as main components, the compounds being obtained by mixing a raw material comprising calcia, a raw material comprising alumina, a raw material comprising boron, and the like, and subjecting the resulting mixture to a heat treatment such as firing in a kiln or melting in an electric furnace, and the compounds having a crystal structure having boron atoms as a solid solution in calcium aluminate.

[0016]

The material composition of CBA has a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a B_2O_3 content of 0.05 to 10%. The $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio is more preferably 0.4 to 0.6. When the $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio is less than 0.15, the shielding effect of chloride ions cannot sufficiently be attained in some cases; and on the other hand, when more than 0.7, quick hardenability is developed, and the pot life cannot be secured in some cases. The B_2O_3 content in CBA is preferably 0.05 to 10%, more preferably 0.1 to 5% and most preferably 0.2 to 3%. When the B_2O_3 content is less than 0.05%, in the case of firing in a kiln, there arises a possibility that much of unreacted aluminum oxide remains; and on the other hand, when more than 10%, the chloride ion penetration resistance is made poor in some cases.

[0017]

The fineness of CBA is, in terms of a Blaine specific surface area value (hereinafter, referred to as a Blaine value), preferably 2,000 to 7,000 cm²/g, more preferably 3,000 to 6,000 cm²/g and most preferably 4,000 to 5,000 cm²/g. When the Blaine value of CBA is 2,000 cm²/g or more, a sufficient shielding effect of chloride ions is attained; and on the other hand, when 7,000 cm²/g or less, the development of quick hardenability is suppressed and the effect of being capable of securing the pot life is attained.

[0018]

Raw materials to be used for production of CBA are as follows.

[0019]

Raw materials containing calcia are not particularly limited, and examples thereof used include quick lime (CaO), slaked lime (Ca(OH)₂) and limestone (CaCO₃), commercially available as industrial raw materials.

[0020]

Raw materials containing alumina are not particularly limited, and examples thereof used include Al₂O₃, aluminum hydroxide and bauxite, commercially available as industrial raw materials. Particularly bauxite, since containing B₂O₃ besides Al₂O₃, is preferable.

[0021]

Raw materials containing boron are not particularly limited, and examples thereof that can be used include any of B_2O_3 obtained by crushing, processing and refining borate minerals commercially available as industrial raw materials, B_2O_3 obtained by recovery from waste hydrochloric acid resulting from cleaning steel materials followed by refining, and the like.

[0022]

There may further be concurrently used, for example, MgO , SiO_2 , R_2O (R is an alkali metal), Fe_2O_3 , TiO_2 and Ti_2O_3 , in the range of not impairing the object of the present invention.

[0023]

CBA is obtained by mixing a raw material comprising calcia, a raw material comprising alumina, a raw material comprising boron, and if suitable, other raw materials, and subjecting the resulting mixture to a heat treatment such as firing in a kiln or melting in an electric furnace. The firing temperature is, though depending on blending of the raw materials, preferably $1200^{\circ}C$ or more and more preferably $1300^{\circ}C$ or more. When the firing temperature is less than $1200^{\circ}C$, the reaction does not efficiently progress, and there arises a possibility that unreacted Al_2O_3 remains.

[0024]

Cements usable in embodiments of the present invention include various types of portland cements such

as ordinary, high-early-strength, ultrahigh-early-strength, low-heat and moderate heat ones, various types of mixed cements of these portland cements mixed with blast furnace slag, fly ash or silica, filler cements of these cements mixed with limestone power or slowly cooled blast furnace slag micropowder, and portland cements such as environmentally friendly cements (ecocements) produced by using incineration ash of urban refuse or incineration ash of sewage sludge as a raw material; and one or two or more among these may be used.

[0025]

In an embodiment of the present invention, by blending the above-mentioned cement with the cement admixture, a cement composition can be obtained.

[0026]

The amount of the cement admixture to be used is not particularly limited, and is usually, in 100 parts of the cement composition composed of the cement and the cement admixture, preferably 1 to 30 parts and more preferably 5 to 15 parts. When the amount of the cement admixture to be used is less than 1 part, there are some cases where there cannot be attained a sufficient rustproofing effect, a shielding effect of chloride ions and an effect of suppressing leaching of Ca ions; and on the other hand, when more than 30 parts, quick hardenability is developed and a sufficient pot life cannot be secured in some cases.

[0027]

With regard to the amount of water to be used in the cement composition, the water/cement composition ratio is preferably 0.25 to 0.7 and more preferably 0.3 to 0.65. When the amount of water to be blended is small, pumpability and workability are reduced and shrinkage and the like are caused in some cases; and on the other hand, when the amount of water to be blended is excessive, the strength developability is reduced in some cases.

[0028]

In preparations of the above cement admixture and cement composition, each material may be mixed in the execution time, or part of or all of the materials are allowed to be mixed previously.

[0029]

In the cement composition according to embodiments of the present invention, in addition to the cement, the cement admixture, fine aggregates such as sand and coarse aggregates such as gravel, there may concurrently be used one or two or more of the group consisting of admixtures including expansive admixtures, quick hardeners, water reducers, AE water reducers, high-performance water reducers, high-performance AE water reducers, defoaming agents, thickeners, conventional rust-proofing agents, antifreezing admixtures, shrinkage reducers and setting regulators, clay minerals such as bentonite, anion exchangers such as hydrotalcite, slags such as granulated

blast furnace slag micropowder and slowly cooled blast furnace slag micropowder, and limestone micropowder, in the range of not substantially inhibit the object of the present invention.

[0030]

As a mixing apparatus, any existing apparatus may be used, and there may be used, for example, a tilted cylinder mixer, an omni mixer, a Henschel mixer, a V-type mixer, and a Nauta mixer.

[0031]

Hereinafter, the present invention will be described in more detail by way of Examples and Comparative Examples, but the present invention is not limited thereto.

Examples

[0032]

(Experimental Example 1)

Calcium carbonate as a first grade reagent and aluminum oxide as a first grade reagent were blended so as to provide molar ratios in terms of oxide indicated in Table 1; and B_2O_3 as a first grade reagent was blended in the resulting blends so as to provide each content indicated in Table 1; and the resulting blends were fired in an electric furnace. The blends having a CaO/Al_2O_3 molar ratio of 0.7 were fired at $1400^{\circ}C$ for 3 hours and then slowly cooled; the blends having a CaO/Al_2O_3 molar

ratio of 0.6, at 1450°C; the blends having a CaO/Al₂O₃ molar ratio of 0.4, at 1500°C; and the blends having a CaO/Al₂O₃ molar ratio of 0.15, at 1550°C, respectively, to thereby fabricate CBAs. The Blaine values were regulated at 4,000 cm²/g. Here, for comparison, a sample having no B₂O₃ added therein, a sample having SiO₂ added therein in place of B₂O₃, and a sample having Na₂O added therein in place of B₂O₃ were also fabricated under the same conditions. For the fabricated samples, the presence/absence of an unreacted substance was examined by using X-ray diffraction. The results are shown in Table 1.

[0033]

(Test method)

X-ray diffraction: the case where diffraction peaks of the unreacted substance (aluminum oxide) were clearly observed was defined as × (poor); the case where the peaks remained a little, as △ (fair); and the case where no peaks were observed, as ○ (good).

[0034]

[Table 1]

Experiment No.	CaO/Al ₂ O ₃ Molar Ratio	B ₂ O ₃ (%)	Presence/Absence of Unreacted Substance Al ₂ O ₃
1-1	0.15	0.05	△
1-2		0.1	△
1-3		0.2	○
1-4		3	○
1-5		5	○
1-6		10	○
1-7	0.4	0.05	○
1-8		0.1	○
1-9		0.2	○
1-10		3	○
1-11		5	○
1-12		10	○
1-13	0.6	0.05	○
1-14		0.1	○
1-15		0.2	○
1-16		3	○
1-17		5	○
1-18		10	○
1-19	0.7	0.05	○
1-20		0.1	○
1-21		0.2	○
1-22		3	○
1-23		5	○
1-24		10	○
1-25	0.15	0	×
1-26	0.4	0	×
1-27	0.6	0	×
1-28	0.7	0	×
1-29	0.4	0.5*	△
1-30	0.4	0.5**	△

* a case where silicon oxide was added in place of B₂O₃

** a case where 0.5% in terms of Na₂O of sodium carbonate was added in place of B₂O₃

[0035]

From Table 1, it is clear that by adding a proper amount of boron, no unreacted aluminum oxide remained even at the above firing temperature.

[0036]

For the samples having no boron added therein, in order to eliminate the diffraction peaks of the unreacted aluminum oxide, further firing was needed at 1500°C for the case having a CaO/Al₂O₃ molar ratio of 0.7; at 1550°C for the case having a CaO/Al₂O₃ molar ratio of 0.6; at 1600°C for the case having a CaO/Al₂O₃ molar ratio of 0.4; and at 1650°C or more for the case having a CaO/Al₂O₃ molar ratio of 0.15.

[0037]

Figure 1 shows X-ray diffraction spectra of the samples obtained while the amount of B₂O₃ blended was varied relative to CaO and Al₂O₃ (represented as CA₂). The CaO/Al₂O₃ molar ratio in the samples was set to 0.5, and then, B₂O₃ was added so as to provide proportions of 0.5, 1.0 and 1.5% by weight in terms of B₂O₃ by substitution of Al₂O₃ by B₂O₃. The firing conditions were a temperature-rise rate of 10°C/min and retention at 1400°C for 30 min. The measurement conditions included use of a powder X-ray diffraction analyzer (XRD, manufactured by Rigaku Corp., Multiflex type) and Cuα as a target, and a tube voltage of 40 kV, a tube current of

40 mA, a step width of 0.02° and a scanning speed of $2.0^\circ/\text{min}$.

[0038]

Spectra in Figure 1 are ones of the respective samples having amounts of B_2O_3 blended of 0%, 0.5%, 1.0% and 5.0% in order from the top in the figure. From the spectra at the vicinity of $2\theta = 30^\circ$, it is clear that with no addition of B_2O_3 , CaAl_2O_4 was produced as a by-product, whereas with the addition of B_2O_3 , the peak originating from CaAl_2O_4 disappeared. It is further clear that peaks at the vicinity of $2\theta = 25.5^\circ$ shifted slightly to the left as the amount of B_2O_3 added increased, and by-production of Al_2O_3 (corundum) was suppressed. From the above, it is understandable that the addition of B_2O_3 made only a single phase of CA_2 to be obtained.

[0039]

(Experimental Example 2)

Cement compositions were each fabricated by using a CBA indicated in Table 2 and blending 7 parts of the CBA in 100 parts of a cement composition composed of a cement and the CBA, and mortars of a water/cement compositional ratio of 0.5 were each fabricated according to JIS R5201:2015. The mortars were used to examine the rustproofing effect, the compressive strength, the chloride penetration depth, the amount of Ca ions leached, and the sulfate resistance. The results are shown in Table 2.

[0040]

(Materials used)

CBA-A: Calcium carbonate as a first grade reagent and aluminum oxide as a first grade reagent were blended in predetermined proportions; and B_2O_3 as a first grade reagent was blended so as to provide a B_2O_3 content of 0.2%; and as in Experimental Example 1, the resulting blend was fired at 1550°C for 3 hours in an electric furnace and then slowly cooled. The CaO/Al_2O_3 molar ratio: 0.1; and the Blaine value: 4,000 cm^2/g

CBA-B: Experiment No. 1-3, The CaO/Al_2O_3 molar ratio: 0.15; B_2O_3 : 0.2%; and the Blaine value: 4,000 cm^2/g

CBA-C: Experiment No. 1-9, The CaO/Al_2O_3 molar ratio: 0.4; B_2O_3 : 0.2%; and the Blaine value: 4,000 cm^2/g

CBA-D: Experiment No. 1-15, The CaO/Al_2O_3 molar ratio: 0.6; B_2O_3 : 0.2%; and the Blaine value: 4,000 cm^2/g

CBA-E: Experiment No. 1-21, The CaO/Al_2O_3 molar ratio: 0.7; B_2O_3 : 0.2%; and the Blaine value: 4,000 cm^2/g

CBA-F: Calcium carbonate as a first grade reagent and aluminum oxide as a first grade reagent were blended in predetermined proportions; and B_2O_3 as a first grade reagent was blended so as to provide a B_2O_3 content of 0.2%; and as in Experimental Example 1, the resulting blend was fired at 1400°C for 3 hours in an electric furnace and then slowly cooled. The CaO/Al_2O_3 molar ratio: 0.9; B_2O_3 : 0.2%; and the Blaine value: 4,000 cm^2/g

CBA-G: Experiment No. 1-26, The $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio: 0.4; the Blaine value: 4,000 cm^2/g ; and containing no boron

CBA-H: Experiment No. 1-29, The $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio: 0.4; SiO_2 : 0.5%; and the Blaine value: 4,000 cm^2/g

CBA-I: Experiment No. 1-30, The $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio: 0.4; Na_2O : 0.5%; and the Blaine value: 4,000 cm^2/g

Cement: ordinary portland cement, commercially available product

Fine aggregate: standard sand used in JIS R5201:2015

Water: tap water

[0041]

(Evaluation methods)

Rustproofing effect: the rustproofing effect was checked by an accelerating test in which chloride ions were added to a mortar so as to provide a concentration of 10 kg/m^3 , and a round steel reinforcement was put in and heat cured at 50°C. The case where no rust was generated on the reinforcement in one year of aging was judged as good; the case where rust was generated in an area of 1/10 thereof or less in the one year was judged as fair; and the case where rust was generated in an area exceeding 1/10 thereof in the one year was judged as poor.

Compressive strength: the compressive strengths of one day and 28 days of aging were measured according to JIS R5201:2015.

Chloride penetration depth: the chloride ion penetration resistance was evaluated. A columnar mortar test specimen of 10 cm ϕ $\times$ 20 cm which after formwork removal, had been cured in water at 20°C until 28 days of aging was dipped in an artificial seawater (salt concentration: 3.5%) at 30°C for 12 weeks, and thereafter, the chloride penetration depth was measured by a fluorescein-silver nitrate method. 8 places on portions where no browning occurred in cross-sections of the mortar test specimen were measured with calipers, and the average value of the measurements was defined as the chloride penetration depth.

Leaching of Ca ions: a mortar test specimen (4 $\times$ 4 $\times$ 16 cm) cured in an environment of 20°C and a humidity of 60% until 28 days of aging was dipped in 10 liters of pure water for 28 days, and the concentration of Ca ions dissolved in the liquid phase was measured.

Sulfate resistance: a mortar test specimen (4 $\times$ 4 $\times$ 16 cm) cured in an environment of 20°C and a humidity of 60% until 28 days of aging was dipped in a 10% Na₂SO₄ solution for 25 weeks, and the expansion coefficient was measured.

[0042]

[Table 2]

Experiment No.	CBA	Rustproofing Effect	Compressive Strength (N/mm ²)		Chloride Penetration Depth (mm)	Leaching of Ca Ions (mg/l)	Sulfate Resistance (%)	Remarks
			1 day	28 days				
2-1	-	poor	12.7	53	20	130	0.18	Comparative Example
2-2	A	fair	11.5	50	9	71	0.07	Comparative Example
2-3	B	good	10.7	54	6	27	0.05	Example
2-4	C	good	10.9	56	1	27	0.01	Example
2-5	D	good	10.7	55	2	28	0.01	Example
2-6	E	good	10.8	54	3	29	0.01	Example
2-7	F	*	*	*	*	*	*	Comparative Example
2-8	G	fair	5.7	49	7	45	0.10	Comparative Example
2-9	H	poor	4.3	42	16	99	0.12	Comparative Example
2-10	I	**	**	**	**	**	**	Comparative Example

Experiment No. 2-1 used no cement admixture.

*: No test specimen could be fabricated because being quickly hardened; **: Flowability decreased and setting occurred in about 40 min.

[0043]

From Table 2, it is understood that incorporation of boron enabled the retention of the rustproofing effect and the chloride ion penetration suppressing effect and the suppression of reduction of the initial strength, and further enabled the improvement of the Ca ion leaching resistance and the sulfate resistance.

[0044]

(Experimental Example 3)

Fabrication and evaluations of mortars were carried out as in Experimental Example 2, except for using a CBA fabricated by blending calcium carbonate as a first grade reagent and aluminum oxide as a first grade reagent so as to provide a CaO/Al₂O₃ molar ratio of 0.4, blending B₂O₃

as a first grade reagent so as to provide each B₂O₃ content indicated in Table 3, and as in Experimental Example 1, firing the resulting blends in an electric furnace and then slowly cooling the blends. The results are shown in Table 3.

[0045]

[Table 3]

Experiment No.	B ₂ O ₃ (%)	Rustproofing Effect	Compressive Strength (N/mm ²)		Chloride Penetration Depth (mm)	Leaching of Ca Ions (mg/l)	Sulfate Resistance (%)	Remarks
			1 day	28 days				
2-8	0	fair	5.7	49	7	45	0.10	Comparative Example
3-1	0.01	fair	9.2	54	6	44	0.09	Comparative Example
3-2	0.05	good	10.7	55	2	42	0.02	Example
3-3	0.5	good	10.7	57	2	40	0.01	Example
3-4	1	good	10.7	55	1	40	0.01	Example
3-5	3	good	10.7	56	1	39	0.01	Example
3-6	5	good	10.7	53	3	39	0.01	Example
3-7	10	good	10.9	53	4	40	0.01	Example
3-8	15	fair	10.0	52	6	45	0.07	Comparative Example
3-9	20	fair	9.8	49	11	100	0.10	Comparative Example

[0046]

From Table 3, proper incorporation of boron enabled the retention of the rustproofing effect and the chloride ion penetration suppressing effect and the suppression of reduction of the initial strength, and further enabled the improvement of the Ca ion leaching resistance and the sulfate resistance.

[0047]

(Experimental Example 4)

Fabrication and evaluations of mortars were carried out as in Experimental Example 2, except for using CBA-D having finenesses of powder indicated in Table 4. The results are shown in Table 4.

[0048]

[Table 4]

Experiment No.	Fineness of CBA Compound (cm ² /g)	Rustproofing Effect	Compressive Strength (28 days) (N/mm ²)	Chloride Penetration Depth (mm)	Leaching of Ca Ions (mg/l)	Sulfate Resistance (%)	Remarks
4-1	2000	fair	50	2	57	0.07	Example
4-2	3000	good	53	1	33	0.03	Example
2-5	4000	good	55	2	28	0.01	Example
4-3	5000	good	56	1	30	0.01	Example
4-4	6000	good	55	1	29	0.01	Example
4-5	7000	good	53	2	34	0.03	Example

[0049]

(Experimental Example 5)

Fabrication and evaluations of mortars were carried out as in Experimental Example 2, except for using CBA-D and setting the amounts of the CBA used in 100 parts of cement compositions composed of the cement and the CBA to amounts indicated in Table 5. For comparison, tests using conventional rust preventives were also carried out. The rust preventives were used in 10 parts to 100 parts of the cement. The results are shown in Table 5.

[0050]

(Materials used)

Conventional rust preventive A: lithium nitrite, commercially available product

Conventional rust preventive B: nitrite-type
hydrocalumite, commercially available product

[0051]

[Table 5]

Experiment No.	CBA-D (parts)	Rustproofing Effect	Compressive Strength (28 days) (N/mm ²)	Chloride Penetration Depth (mm)	Leaching of Ca ions (mg/l)	Sulfate Resistance (%)	Remarks
2-1	0	poor	53	20	130	0.18	Comparative Example
5-1	1	fair	54	7	56	0.07	Example
5-2	3	good	55	3	37	0.07	Example
5-3	5	good	56	2	33	0.01	Example
2-5	7	good	55	2	28	0.01	Example
5-4	10	good	56	2	30	0.01	Example
5-5	15	good	55	3	34	0.01	Example
5-6	20	good	54	5	39	0.01	Example
5-7	30	good	54	5	39	0.01	Example
5-8	** A 10	fair	39	14	119	0.16	Comparative Example
5-9	** B 10	fair	34	17	128	0.17	Comparative Example

CBA-D: Proportion (parts) of CBA-D in 100 parts of a cement composition composed of a cement and CBA-D

**: Conventional rust preventives were used.

Industrial Applicability

[0052]

Use of the cement admixture of the present invention, since exhibiting the excellent rustproofing effect, the shielding effect of chloride ions, the effect of suppressing leaching of Ca ions and the sulfate resistance, is suitable for broad applications mainly to marine and river water supply structures, water tanks, slab concretes and the like in civil engineering and construction industries and the like.

Claims

[Claim 1]

A cement admixture, comprising a calcium boron aluminate having a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a B_2O_3 content of 0.05 to 10% by mass.

[Claim 2]

The cement admixture according to claim 1, wherein the calcium boron aluminate has a fineness of 2,000 to 7,000 cm^2/g in terms of a Blaine specific surface area value.

[Claim 3]

A cement composition, comprising a cement, and a cement admixture according to claim 1 or 2.

[Claim 4]

A method for producing a cement composition, the method comprising the steps of:

mixing a raw material comprising calcia, a raw material comprising alumina, and a raw material comprising boron so as to provide a $\text{CaO}/\text{Al}_2\text{O}_3$ molar ratio of 0.15 to 0.7 and a B_2O_3 content of 0.05 to 10% by mass;

firing the mixed raw materials at 1400°C or more, and thereafter crushing the raw materials so as to provide a Blaine specific surface area value of 2000 to 7000 cm^2/g to thereby obtain a calcium boron aluminate; and

mixing the obtained calcium boron aluminate, and a cement.