

Description

Title of Invention: FLY ASH AND CEMENT COMPOSITION CONTAINING SAME

Technical Field

[0001] The present invention relates to a fly ash and a cement composition containing the same.

Background Art

[0002] Fly ash blended cement, which is a cement-based material and is obtained by substituting a part of cement with fly ash, generates a stable compound such as a calcium silicate hydrate through a pozzolan reaction between calcium hydroxide generated through hydration of the cement and the fly ash, to thereby form a dense structure. Accordingly, fly ash blended cement is excellent in water-tightness, chemical resistance, and long-term strength developability.

The amount of heat generated by the pozzolan reaction is smaller than the amount of heat of hydration of Portland cement. Accordingly, the heat of hydration of the fly ash blended cement is smaller than the heat of hydration of Portland cement.

[0003] Fly ash itself is formed of spherical fine particles, and hence can improve fluidity of concrete or the like by a ball bearing action. Therefore, fly ash blended cement enables a reduction in amount of water per unit volume of the concrete or the like at the time of production of concrete or the like, and

thus enables a reduction in drying shrinkage of a hardened body of concrete or the like.

Fly ash blended cement has an effect of reducing an environmental load because, for example, the discharge amount of carbon dioxide and the use amount of a natural resource, such as a raw material (e.g., limestone) or a fossil fuel (e.g., heavy oil), can be reduced at the time of production of cement, and the fly ash, which is a by-product generated through combustion of powdered coal in a thermal power plant, can be effectively utilized.

[0004] Fly ash contains spherical particles and unburnt carbon.

Of those, the spherical particles are obtained as follows: a burnt residue (i.e. suspended material) of powdered coal combusted in a boiler is melted due to high temperature, and is then spheroidized by surface tension in the course of cooling. The surfaces of the spherical particles are melted in the course of formation thereof to be vitrified.

The unburnt carbon has a relatively coarse and porous shape. The unburnt carbon has a large particle size, and hence it is considered that combustion of a burnt residue thereof does not proceed, and the unburnt carbon does not become spherical particles. The unburnt carbon inhibits the ball bearing effect of the spherical particles to cause a reduction in fluidity of concrete or the like and thus a reduction in strength thereof.

When fly ash containing unburnt carbon at a high content is

used as one of the materials of concrete or mortar, the unburnt carbon contained in the fly ash is considered to have a risk of floating along with bleeding water to the surface of the concrete or the like at the time of placing (i.e. casting or pouring) of the concrete or the like, resulting in the occurrence of black color unevenness on the surface of the concrete or the like.

[0005] As a method of suppressing the occurrence of such black color unevenness, for example, methods described in Patent Literatures 1 to 2 below have been proposed.

In Patent Literature 1, there is described a method of reforming fly ash, characterized by including a step of ashing the fly ash until the amount of unburnt carbon becomes 1 wt% or less, followed by finely pulverizing the fly ash so as to give a 50% passage diameter of from 5 μm to 15 μm , or a step of finely pulverizing the fly ash so as to give a 50% passage diameter of from 5 μm to 15 μm , followed by ashing the fly ash until the amount of unburnt carbon becomes 1 wt% or less.

[0006] In Patent Literature 2, there is described a method of reducing an unburned carbon content in coal ash, characterized by including loading coal ash containing unburned carbon into a dry pulverizer to crush and finely pulverize the unburned carbon aggregating and adhering to fly ash in the coal ash, followed by loading the fly ash and the unburned carbon into a dry classifier to separate the unburned carbon having been finely pulverized from the fly ash.

The terms "coal ash", "fly ash", and "unburned carbon" in Patent Literature 2 correspond to the "fly ash", the "spherical particles", and the "unburnt carbon" in the above-mentioned "fly ash" (i.e. fly ash that contains spherical particles and unburnt carbon), respectively.

Citation List

Patent Literature

[0007] [Patent Literature 1] JP H11-11999 A
 [Patent Literature 2] JP 2010-30885 A

Summary of Invention

Technical Problem

[0008] The method including a step of ashing the fly ash to reduce the amount of the unburnt carbon, as described in Patent Literature 1, has problems in that the step of ashing the fly ash requires energy, and in that it takes time and effort to conduct the step of ashing the fly ash, resulting in complicated production.

 The method involving combining the crushing and fine pulverization by using the pulverizer with the separation of the unburned carbon by using the classifier, as described in Patent Literature 2, has problems in that the crushing and fine pulverization requires energy, and in that it takes time and effort to use the dry pulverizer and the dry classifier, resulting in complicated production.

[0009] An object of the present invention is to provide a fly ash, which, when used as one of the materials of concrete or mortar (i.e. concrete or the like), can improve fluidity of the concrete or the like before hardening to improve workability thereof, and can suppress occurrence of color unevenness on the surface of the concrete or the like after hardening, even though the fly ash contains unburnt carbon at a high content, and a cement composition containing the fly ash.

Solution to Problem

[0010] The inventors of the present invention have made extensive investigations in order to solve the above-mentioned problems, and as a result, have found that the above-mentioned object of the present invention can be achieved by using a fly ash having an ignition loss of from 5.0 mass% to 20 mass% and a ratio of a BET specific surface area to the ignition loss falling within a specific range. Thus, the present invention has been completed.

[0011] That is, the present invention provides the following items [1] to [6].

[1] A fly ash, which has an ignition loss of from 5.0 mass% to 20 mass% and a ratio of a BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of less than 0.3.

[2] The fly ash according to Item [1], wherein the fly ash has a Blaine specific surface area of from 2,000 cm^2/g to 5,000 cm^2/g .

[3] The fly ash according to Item [1] or [2], wherein the fly ash

has a content ratio (i.e. a percentage) of SiO_2 of 40 mass% or more and a content ratio (i.e. a percentage) of Al_2O_3 of from 16 mass% to 30 mass%.

[4] A cement composition, including the fly ash of any one of Items [1] to [3] and Portland cement, wherein the cement composition has a ratio (i.e. a percentage) of the fly ash of from 1 mass% to 40 mass% with respect to a total amount (100 mass%) of the fly ash and the Portland cement.

[5] The cement composition according to Item [4], further including one or more kinds of powders selected from the group consisting of limestone powder, ground granulated blast-furnace slag (i.e. blast furnace slag fine powder), and natural pozzolan powder.

[6] A method of selecting the fly ash of any one of Items [1] to [3], the method including the steps of: preparing one or more kinds of fly ashes; measuring an ignition loss and a BET specific surface area of each of the one or more kinds of fly ashes; calculating, based on the ignition loss and the BET specific surface area obtained in the measuring step, a ratio of the BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of each of the one or more kinds of fly ashes; and selecting, based on the ignition loss obtained in the measuring step and the ratio obtained in the calculating step, a fly ash having an ignition loss of from 5.0 mass% to 20 mass% and a ratio of the BET specific surface area/the ignition loss of less than 0.3, from the one or more kinds of fly ashes.

Advantageous Effects of Invention

[0013] The fly ash of the present invention, when used as one of the materials of concrete or mortar (hereinafter sometimes abbreviated as "concrete or the like"), can improve fluidity of the concrete or the like before hardening to improve workability thereof, and can suppress occurrence of color unevenness on the surface of the concrete or the like after hardening, even though the fly ash contains unburnt carbon at a high content.

Description of Embodiments

[0014] A fly ash of the present invention has an ignition loss of from 5.0 mass% to 20 mass% and a ratio of a BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of less than 0.3.

The fly ash of the present invention is described below in more detail.

The fly ash of the present invention has an ignition loss of from 5.0 mass% to 20 mass%, preferably from 5.5 mass% to 19 mass%, more preferably from 6.0 mass% to 18 mass%, particularly preferably from 6.0 mass% to 16 mass%.

When the ignition loss is less than 5.0 mass%, or when the ignition loss is more than 20 mass%, the fluidity of concrete or the like before hardening is reduced, and the occurrence of color unevenness is not sufficiently suppressed on the surface of the concrete or the like after hardening.

[0015] The ratio of "BET specific surface area (unit: m^2/g)/ignition loss (unit: mass%)" in the present invention is less than 0.3, preferably from 0.01 to 0.28, more preferably from 0.02 to 0.25, particularly preferably from 0.03 to 0.20. As used herein, the ratio is represented with its unit omitted.

When the value of the ratio is more than 0.3, the fluidity of the concrete or the like before hardening is reduced, and the occurrence of color unevenness is not sufficiently suppressed on the surface of the concrete or the like after hardening. When the value of the ratio is 0.01 or more, the selection of such fly ash is more easily performed.

The fly ash of the present invention has a BET specific surface area of preferably from $0.1 \text{ m}^2/\text{g}$ to $5 \text{ m}^2/\text{g}$, more preferably from $0.15 \text{ m}^2/\text{g}$ to $4 \text{ m}^2/\text{g}$, still more preferably from $0.2 \text{ m}^2/\text{g}$ to $3 \text{ m}^2/\text{g}$, particularly preferably from $0.2 \text{ m}^2/\text{g}$ to $2.5 \text{ m}^2/\text{g}$.

When the value of the BET specific surface area is $0.1 \text{ m}^2/\text{g}$ or more, the selection of such fly ash is more easily performed. When the value of the BET specific surface area is $5 \text{ m}^2/\text{g}$ or less, the ratio of "BET specific surface area (unit: m^2/g)/ignition loss (unit: mass%)" is often less than 0.3, and the selection of the fly ash corresponding to the present invention is more easily performed.

[0016] The fly ash of the present invention has a Blaine specific surface area of preferably from $2,000 \text{ cm}^2/\text{g}$ to $5,000 \text{ cm}^2/\text{g}$, more preferably from $2,100 \text{ cm}^2/\text{g}$ to $4,500 \text{ cm}^2/\text{g}$, still more

preferably from 2,200 cm²/g to 4,000 cm²/g, particularly preferably from 2,250 cm²/g to 3,800 cm²/g.

When the value of the Blaine specific surface area is 2,000 cm²/g or more, strength developability is more improved. When the value of the Blaine specific surface area is 5,000 cm²/g or less, the selection of such fly ash is more easily performed.

The Blaine specific surface area may be measured, for example, by a method described in "JIS R 5201:2015 Physical testing methods for cement."

The fly ash of the present invention has a content ratio of SiO₂ (i.e. silica) of preferably 40 mass% or more, more preferably from 41 mass% to 70 mass%, still more preferably from 42 mass% to 65 mass%, still more preferably from 43 mass% to 60 mass%, still more preferably from 44 mass% to 56 mass%, particularly preferably from 45 mass% to 55 mass%.

When the content ratio is 40 mass% or more, there are advantages of for example, the formation of a dense structure through a pozzolan reaction being more promoted. When the content ratio is 70 mass% or less, the selection of such fly ash is more easily performed.

[0017] The fly ash of the present invention has a content ratio of Al₂O₃ (i.e. alumina) of preferably from 16 mass% to 30 mass%, more preferably from 17 mass% to 28 mass%, still more preferably from 18 mass% to 27 mass%, particularly preferably from 19 mass% to 26 mass%.

When the content ratio is 16 mass% or more, there are advantages of for example, the formation of a dense structure through a pozzolan reaction being more promoted. When the content ratio is 30 mass% or less, the selection of such fly ash is more easily performed.

[0018] The cement composition of the present invention includes the before-mentioned fly ash and Portland cement.

Examples of the Portland cement include ordinary Portland cement, high-early-strength Portland cement, moderate-heat Portland cement, low-heat Portland cement, and sulfate-resistant Portland cement.

The Blaine specific surface area of the Portland cement is not particularly limited, but from the viewpoint of ease of availability or the like, is preferably from 2,500 cm²/g to 5,000 cm²/g, more preferably from 2,800 cm²/g to 4,700 cm²/g.

In the cement composition of the present invention, the ratio (i.e. percentage) of the fly ash is preferably from 1 mass% to 40 mass%, more preferably from 2 mass% to 38 mass%, still more preferably from 5 mass% to 35 mass%, still more preferably from 10 mass% to 33 mass%, still more preferably from 15 mass% to 31 mass%, particularly preferably from 20 mass% to 30 mass% with respect to (i.e. in) the total amount (100 mass%) of the fly ash and the Portland cement.

When the ratio of the fly ash is 1 mass% or more, the effect exhibited by blending the fly ash (specifically, improving the

fluidity to improve workability) can be more increased. When the ratio of the fly ash is 40 mass% or less, fine unburnt carbon particles or coarse particles each having a high bulk specific gravity are prevented from floating with bleeding water to the surface of the concrete or the like before hardening, and the occurrence of color unevenness can be more effectively suppressed.

[0019] The cement composition of the present invention may further contain a powder (hereinafter abbreviated as "other powder"), such as limestone powder, ground granulated blast-furnace slag, or natural pozzolan powder.

Other powders may be used alone or in combination thereof.

The preferred Blaine specific surface area of other powders is preferably from 2,500 cm²/g to 12,000 cm²/g, more preferably from 2,800 cm²/g to 11,000 cm²/g, still more preferably from 3,000 cm²/g to 10,000 cm²/g from the viewpoints of, for example, workability at the time of kneading of the concrete or the like and the formation of a dense structure in the concrete or the like after hardening.

[0020] The preferred Blaine specific surface areas of other powders according to type are as described below.

The preferred Blaine specific surface area of limestone powder is preferably from 3,000 cm²/g to 11,000 cm²/g, more preferably from 4,000 cm²/g to 10,000 cm²/g, still more preferably from 5,000 cm²/g to 9,500 cm²/g, particularly preferably from 6,000 cm²/g to 9,000 cm²/g.

The preferred Blaine specific surface area of ground

granulated blast-furnace slag is preferably from 2,500 cm²/g to 7,000 cm²/g, more preferably from 3,000 cm²/g to 6,000 cm²/g, particularly preferably from 3,500 cm²/g to 5,000 cm²/g.

The preferred Blaine specific surface area of natural pozzolan powder is preferably from 2,500 cm²/g to 7,000 cm²/g, more preferably from 3,000 cm²/g to 6,000 cm²/g, particularly preferably from 3,500 cm²/g to 5,000 cm²/g.

[0021] When the cement composition of the present invention contains limestone powder, the ratio of limestone powder is preferably 25 mass% or less, more preferably 20 mass% or less, particularly preferably 15 mass% or less with respect to the total amount (100 mass%) of limestone powder and Portland cement. When the ratio of limestone powder is more than 25 mass%, the strength developability of the concrete or the like is reduced.

When the cement composition of the present invention contains ground granulated blast-furnace slag or natural pozzolan powder, the ratio of ground granulated blast-furnace slag or natural pozzolan powder (when both of ground granulated blast-furnace slag and natural pozzolan powder are contained, the ratio of the total amount of the two powders) is preferably 25 mass% or less, more preferably 20 mass% or less, particularly preferably 15 mass% or less with respect to the total amount (100 mass%) of ground granulated blast-furnace slag, natural pozzolan powder and Portland cement. When the ratio of ground granulated blast-furnace slag or natural pozzolan powder is more than 25 mass%, the fluidity of the

concrete or the like is reduced.

[0022] The cement composition of the present invention can be used as mortar or concrete by containing water, an aggregate (i.e. fine aggregate, coarse aggregate), and the like in addition to the above-mentioned materials.

Examples of fine aggregate include river sand, mountain sand, land sand, sea sand, crushed sand, silica sand, slag fine aggregate, and lightweight fine aggregate.

Examples of coarse aggregate include river gravel, mountain gravel, land gravel, sea gravel, crushed stone, silica stone, slag coarse aggregate, and lightweight coarse aggregate.

It is appropriate to use recycled aggregate as well as natural aggregate as the aggregate (i.e. fine aggregate or coarse aggregate) used in the invention.

Examples of water include tap water, sewage treatment water, and supernatant water of ready-mixed concrete.

[0023] The cement composition of the present invention may contain an admixture for reducing the amount of water, such as a water-reducing admixture, an air-entraining (AE) and water-reducing admixture, a high-range water-reducing admixture, or an air-entraining (AE) and high-range water-reducing admixture. Examples of a water-reducing component in each of those admixtures include a polycarboxylic acid, a naphthalenesulfonic acid-formaldehyde condensate, a melaminesulfonic acid-formaldehyde condensate, and lignin sulfonic acid, and salts

thereof.

The cement composition of the present invention may contain an expansive additive, a shrinkage reducing agent, or the like in order to suppress shrinkage cracking in the concrete or the like after hardening.

The cement composition of the present invention may contain an air content controlling agent, a retarding admixture, an antifoaming agent, or any other agent for various purposes.

[0024] A method of selecting a fly ash of the present invention includes the steps of : preparing one or more kinds (e.g., 5 to 20 kinds) of fly ashes; measuring an ignition loss and a BET specific surface area of each of the one or more kinds of fly ashes; calculating, based on the ignition loss and the BET specific surface area obtained in the measuring step, a ratio of the BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of each of the one or more kinds of fly ashes; and selecting, based on the ignition loss obtained in the measuring step and the ratio obtained in the calculating step, a fly ash having an ignition loss of from 5.0 mass% to 20 mass% and a ratio of the BET specific surface area/the ignition loss of less than 0.3, from the one or more kinds of fly ashes.

The ignition loss may be measured, for example, by a method described in "JIS A 6201:2015 Fly ash for use in concrete."

The BET specific surface area may be measured, for example, by a method described in "JIS R 1626:1996 Measuring methods for

the specific surface area of fine ceramic powders by gas adsorption using the BET method."

Examples

[0025] The present invention is hereinafter described by way of Examples.

The present invention is not limited to Examples to be described below, and various embodiments may be adopted as long as the embodiments are encompassed in the scope of claims for a patent.

[0026] 1. Used Materials (except Fly Ash)

(1) Ordinary Portland cement (manufactured by Taiheiyo Cement Corporation); C₃S (A-lite): 60.1 mass%, C₂S (B-lite): 13.1 mass%, C₃A (aluminate phase): 9.0 mass%, C₄AF (ferrite phase): 9.8 mass%, gypsum (SO₃ equivalent): 2.0 mass%, Blaine specific surface area: 3,250 cm²/g

(2) Limestone powder; Blaine specific surface area: 8,500 cm²/g

(3) Ground granulated blast-furnace slag; Blaine specific surface area: 4,230 cm²/g

(4) Natural pozzolan powder; Blaine specific surface area: 3,980 cm²/g

(5) Fine aggregate; standard sand described in "JIS R 5201:2015 Physical testing methods for cement"

(6) Tap water

[0027] 2. Used Material (Fly Ash)

The characteristics of 12 kinds of fly ashes (represented as "FA1" to "FA12" in Table 1) used in tests are shown in Table 1.

"FA1" to "FA8" satisfy all the conditions of the fly ash specified in the present invention. "FA9" to "FA12" do not satisfy one or more of the conditions of the fly ash specified in the present invention.

[0028]

[Table 1]

Fly ash	Ignition loss (mass%)	BET specific surface area (m ² /g)	Ratio of BET specific surface area/ignition loss	Blaine specific surface area (cm ² /g)	Content ratio of SiO ₂ (mass%)	Content ratio of Al ₂ O ₃ (mass%)
FA1	15.8	1.5	0.09	2,380	49.4	22.5
FA2	6.3	0.2	0.03	2,460	53.6	25.2
FA3	10.4	1.3	0.12	2,360	53.2	24.0
FA4	14.8	2.5	0.17	3,630	49.7	23.1
FA5	11.2	0.9	0.08	2,300	52.0	22.2
FA6	7.3	0.5	0.07	3,060	47.1	20.3
FA7	11.4	0.9	0.08	2,320	53.7	22.9
FA8	7.8	0.7	0.09	3,010	54.7	22.4
FA9	28.0	3.6	0.13	3,330	41.7	19.6
FA10	2.7	1.4	0.53	2,950	56.2	23.6
FA11	8.5	6.4	0.75	3,520	56.7	23.0
FA12	14.2	9.8	0.69	3,970	52.3	21.8

[0029] 3. Test 1

(1) Preparation of Mortar

A cement composition (i.e. a blended cement produced by adding fly ash to cement) was prepared by blending ordinary Portland cement and each fly ash so that the ratio of the fly ash was 25 mass% with respect to the total amount (100 mass%) of the ordinary Portland cement and the fly ash.

With regard to mortar prepared by using the obtained cement composition (i.e. the obtained blended cement), the flow value of the mortar before hardening was evaluated (in more detail, relatively evaluated based on mortar free of the fly ash), and color unevenness on the surface of a hardened body of the mortar was evaluated. The details thereof are as described below.

[0030] (2) Evaluation of Flow Value of Mortar

The magnitude of the flow value of mortar containing each fly ash when the flow value of mortar free of the fly ash was defined as 100 (hereinafter referred to as "percent flow") was calculated.

The percent flow may be calculated by the formula of: "flow value of mortar containing each fly ash"×100/"flow value of mortar free of fly ash."

The flow value was measured by a method described in "JIS A 6201:2015 Fly ash for use in concrete."

The results are shown as "percent flow" in Table 2.

[0031] (3) Evaluation of Color Unevenness on Surface of Hardened Body of Mortar

For each fly ash, mortar containing the fly ash, Portland cement, fine aggregate, an antifoaming agent, and water was prepared,

and the surface of a hardened body obtained by hardening the mortar was measured for an L value in the Hunter Lab color system (hereinafter abbreviated as "L value").

The amount of each fly ash was set to such an amount that the ratio of the fly ash was 2.5 mass% with respect to the total amount (100 mass%) of the fly ash and the Portland cement.

Regarding the blending ratio of the used materials of the mortar (excluding the antifoaming agent), the amounts of the fine aggregate and water were set to 300 parts by mass and 50 parts by mass, respectively, with respect to 100 parts by mass of the total amount of the Portland cement and the fly ash with reference to "JIS R 5201:2015 Physical testing methods for cement."

The amount of the antifoaming agent was set to 0.03 part by mass with respect to 100 parts by mass of the total amount of the fly ash and the Portland cement so that the air content in the mortar was less than 2.5%.

[0032] The kneading and molding of the mortar was performed in conformity with "JIS R 5201:2015 Physical testing methods for cement." At the time of kneading, the antifoaming agent was loaded into a mixer along with water. After the molding, the resultant molded body was subjected to curing in moist air for 3 days under the temperature condition of 20°C, and then the surface of the resultant hardened body of the mortar was measured for an L value.

The measurement of the L value of the surface of the hardened body of the mortar was performed as described below.

First, among black spots generated on the surface of the mortar in a mottled manner, 15 black spots each having a particularly high degree of blackness were selected through visual observation. Next, the L values of substantial center portions of the selected black spots were measured with a spectrophotometer (manufactured by Nippon Denshoku Industries Co., Ltd., product name "NR-3000"). Finally, an average value of the measured values of the 15 black spots was calculated. The obtained values are shown as "color unevenness (L value)" in Table 2.

[0033] (4) Activity Index (Reference Data)

The activity index (on day 7, day 28, and day 91) of each fly ash was measured in conformity with "JIS A 6201:2015 Fly ash for use in concrete." The results are shown in Table 2.

[0034]

[Table 2]

Fly ash	Percent flow	Color unevenness (L value)	Activity index		
			Day 7	Day 28	Day 91
FA1	106	48.4	67	76	89
FA2	108	56.0	67	75	89
FA3	107	53.0	66	74	88
FA4	107	46.9	68	77	92
FA5	108	51.5	66	75	87
FA6	109	58.0	67	78	92
FA7	108	53.6	65	74	85
FA8	108	57.5	67	75	89
FA9	92	42.1	66	74	86
FA10	94	44.0	69	76	89
FA11	93	41.2	67	78	92
FA12	91	40.1	68	78	91

[0035] From Table 2, it is found that the fly ash (see "FA1"

to "FA8" in Table 2) that satisfies all the conditions specified in the present invention can improve the fluidity (see the "percent flow" in Table 2) of the mortar to thereby improve the workability of the mortar, and suppresses the occurrence of color unevenness (see "color unevenness (L value)" in Table 2) on the surface of the hardened body of the mortar, even though the fly ash has an ignition loss (i.e. the content of unburnt carbon) of more than 5 mass%. Meanwhile, it is found that the fly ash (see "FA9" to "FA12" in Table 2) that does not satisfy one or more of the conditions of the fly ash specified in the present invention leads to a reduction in fluidity of the concrete or the like before hardening, and insufficient suppression of the occurrence of color unevenness on the surface of the concrete or the like after hardening.

[0036] 4. Test 2

(1) Preparation of Mortar

A cement composition (i.e. a blended cement produced by adding fly ash and other materials to cement) was prepared by mixing the ordinary Portland cement, the fly ash ("FA6" or "FA10"), and a powder other than these two powders (i.e. limestone powder, ground granulated blast-furnace slag, or natural pozzolan powder; hereinafter also referred to as "other powder").

The amount of each fly ash was determined as described below.

In the evaluation of the flow value of mortar, the amount of each fly ash was set to such an amount that the ratio of the fly ash was 25 mass% with respect to the total amount (100 mass%) of

the ordinary Portland cement, the fly ash, and the other powder.

In the evaluation of the color unevenness on the surface of a hardened body of the mortar, the amount of each fly ash was set to such an amount that the ratio of the fly ash was 2.5 mass% with respect to the total amount (100 mass%) of the ordinary Portland cement, the fly ash, and the other powder.

The amount of the other powder (i.e. limestone powder, ground granulated blast-furnace slag, or natural pozzolan powder) was set to such an amount that the ratio of the other powder was 15 mass% with respect to the total amount (100 mass%) of the ordinary Portland cement and the other powder.

(2) Evaluation of Flow Value and Color Unevenness of Mortar

With regard to mortar prepared by using the obtained cement composition (i.e. the obtained blended cement), the flow value of the mortar before hardening and the color unevenness on the surface of a hardened body of the mortar were evaluated in the same manner as in Test 1 described above.

The results are shown in Table 3.

[0037]

[Table 3]

Fly ash	Other powder	Percent flow	Color unevenness (L value)
FA6	Limestone powder	107	59.3
FA6	Ground granulated blast-furnace slag	108	59.8
FA6	Natural pozzolan powder	111	57.2
FA10	Limestone powder	93	45.8
FA10	Ground granulated blast-furnace slag	93	45.4

FA10	Natural pozzolan powder	94	44.3
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[0038] From Table 3, it is found that the fly ash (i.e. "FA6" in Table 3) that satisfies all the conditions specified in the present invention can improve the fluidity of the mortar to thereby improve the workability the mortar, and suppresses the occurrence of color unevenness on the surface of the hardened body of the mortar, even though the fly ash has an ignition loss (i.e. the content of unburnt carbon) of 7.3 mass% which is large value.

Meanwhile, it is found that the fly ash (i.e. "FA10" in Table 3) that does not satisfy the conditions specified in the present invention leads to a reduction in fluidity of the mortar, and causes remarkable color unevenness on the surface of the hardened body of the mortar and does not suppress the occurrence of color unevenness.

Claims

[Claim 1] A fly ash, which has an ignition loss of from 5.0 mass% to 20 mass% and a ratio of a BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of less than 0.3.

[Claim 2] The fly ash according to claim 1, wherein the fly ash has a Blaine specific surface area of from 2,000 cm^2/g to 5,000 cm^2/g .

[Claim 3] The fly ash according to claim 1 or 2, wherein the fly ash has a content ratio of SiO_2 of 40 mass% or more and a content ratio of Al_2O_3 of from 16 mass% to 30 mass%.

[Claim 4] A cement composition, comprising the fly ash of any one of claims 1 to 3 and Portland cement, wherein the cement composition has a ratio of the fly ash of from 1 mass% to 40 mass% with respect to a total amount (100 mass%) of the fly ash and the Portland cement.

[Claim 5] The cement composition according to claim 4, further comprising one or more kinds of powders selected from the group consisting of limestone powder, ground granulated blast-furnace slag, and natural pozzolan powder.

[Claim 6] A method of selecting the fly ash of any one of claims 1 to 3, the method comprising the steps of:

preparing one or more kinds of fly ashes;

measuring an ignition loss and a BET specific surface area of each of the one or more kinds of fly ashes;

calculating, based on the ignition loss and the BET specific surface area obtained in the measuring step, a ratio of the BET specific surface area (unit: m^2/g)/the ignition loss (unit: mass%) of each of the one or more kinds of fly ashes; and

selecting, based on the ignition loss obtained in the measuring step and the ratio obtained in the calculating step, a fly ash having an ignition loss of from 5.0 mass% to 20 mass% and a ratio of the BET specific surface area/the ignition loss of less than 0.3, from the one or more kinds of fly ashes.