

[DESCRIPTION]

[Title of Invention]

CEMENT COMPOSITION FOR PLASTERING AND MORTAR FOR PLASTERING

[Technical Field]

[0001] The present invention relates to a cement composition for plastering, which exhibits high workability and strength development properties even in warm regions; and a mortar for plastering that contains the cement composition for plastering. Moreover, the term "warm" in this Description means an annual average temperature of 25°C or higher.

[Background Art]

[0002] A variety of mortars for plastering that exhibit high applicability are known as finishing materials for surfaces of structures.

For example, PTL 1 discloses a fly ash mortar which contains fly ash which is finely powdered to a particle size of 20 μm or less without compromising sphericity, cement and fine aggregate. In addition, this fly ash mortar is a structural surface finishing material (a mortar for plastering) in which the degree of substitution of the fly ash relative to the cement is 10 to 30 wt% and the ratio of total mass of fly ash and cement: mass of fine aggregate is 1:1 to 1:2.5.

In addition, PTL 2 discloses a sulfuric acid-resistant hydraulic coating material (a mortar for plastering) that contains slag having a BET specific surface area of 0.75 to

3.3 m²/g and/or fly ash having a BET specific surface area of 1.5 to 3.3 m²/g, aggregate, cement and a water-reducing agent.

[Citation List]

[Patent Literature]

[0003] [PTL 1] Japanese Patent Application Publication No. H03-126652

[PTL 2] Japanese Patent Application Publication No. 2006-248839

[Summary of Invention]

[Technical Problem]

[0004] Mortars for plastering generally contain humectants in order to improve workability and the like. Here, a humectant disclosed in PTL 1 is methyl cellulose (see the section of examples), and the humectant disclosed in PTL 2 is a water-soluble cellulose such as hydroxypropylmethyl cellulose and the like.

However, humectant-containing mortars for plastering have problems such as significantly lower workability in warm regions, and because humectants are generally expensive, there are demands for mortars for plastering that exhibit high workability without using humectants.

Therefore, the object of the present invention is to provide a cement composition for plastering, or the like, which exhibits high workability in warm regions without using a humectant, causes little mortar dripping when coated on a wall, and exhibits high strength development properties.

[Solution to Problem]

[0005] As a result of diligent research into cement compositions for plastering that are able to achieve the object mentioned above, the inventors of the present invention found that the object mentioned above could be achieved by a cement composition for plastering, which contains fly ash that satisfies specific conditions, and thereby completed the present invention.

That is, the present invention is a cement composition for plastering and the like, which has the following features.

[0006] [1] A cement composition for plastering, containing at least fly ash that satisfies all of conditions (F1) to (F5) below and Portland cement, wherein a content of the fly ash is 10 to 50 mass% when a total amount of the fly ash and the Portland cement is taken to be 100 mass%:

(F1) a Blaine specific surface area of the fly ash is 2500 to 6000 cm²/g;

(F2) a mass reduction rate of the fly ash is 5 mass% or less after the fly ash is heated for 15 minutes at a temperature of 975 ± 25°C;

(F3) a content of SiO₂ in the fly ash is 50 mass% or more;

(F4) in the fly ash, a sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed is 2800 to 11,000 cm²/cm³;

(F5) in the fly ash, a sphere equivalent specific surface area of amorphous particles containing Ca (calcium) is 2100 to 22,500 cm^2/cm^3 .

[2] The cement composition for plastering according to [1] above, wherein the fly ash also satisfies condition (F6) below:

(F6) in the fly ash, a sphere equivalent specific surface area of particles in which mullite and an amorphous substance are mixed is 1900 to 9500 cm^2/cm^3 .

[3] The cement composition for plastering according to [1] or [2] above, wherein the fly ash also satisfies condition (F7) below:

(F7) in the fly ash, a sphere equivalent specific surface area of amorphous particles not containing Ca is 2100 to 9000 cm^2/cm^3 .

[4] The cement composition for plastering according to any one of [1] to [3] above, further containing blast furnace slag powder, wherein a content of the blast furnace slag powder is 50 mass% or less when a total amount of the Portland cement, the fly ash and the blast furnace slag powder is 100 mass%.

[5] The cement composition for plastering according to any one of [1] to [4] above, further containing an inorganic powder obtained by pulverizing natural rock, wherein a content of the inorganic powder is 30 mass% or less when a total

amount of the Portland cement, the fly ash, the blast furnace slag powder and the inorganic powder is 100 mass%.

[6] The cement composition for plastering according to any one of [1] to [5] above, further containing one or more types of gypsum selected from among anhydrous gypsum, gypsum hemihydrate and gypsum dihydrate, wherein a content of the gypsum is 3.0 mass% or less in terms of SO_3 when a total amount of the Portland cement, the fly ash, the blast furnace slag powder, the inorganic powder and the gypsum is 100 mass%.

[7] A mortar for plastering including the cement composition for plastering according to any one of [1] to [6] above, fine aggregate and water.

[Advantageous Effects of Invention]

[0007] The mortar for plastering of the present invention, which contains the cement composition for plastering of the present invention, exhibits high workability in warm regions without using a humectant, causes little mortar dripping when coated on a wall, and exhibits high strength development properties.

[Description of Embodiments]

[0008] As mentioned above, the present invention is a cement composition for plastering and a mortar for plastering. First, an explanation will be given of the cement composition for plastering of the present invention.

1. Cement composition for plastering

This cement composition for plastering contains at least fly ash and Portland cement, wherein the content of the fly ash is 10 to 50 mass% when the total amount of the fly ash and the Portland cement is taken to be 100 mass%. If the content of the fly ash is less than 10 mass%, workability of the mortar for plastering deteriorates, and if the content of the fly ash exceeds 50 mass%, the amount of dripping of the mortar for plastering may increase and strength development properties deteriorate. Moreover, the content of the fly ash is preferably 12 to 40 mass%, and more preferably 14 to 35 mass%.

[0009] (i) Portland cement

The Portland cement used in the present invention can be one or more types selected from among ordinary Portland cement, high-early-strength Portland cement, moderate heat Portland cement and low heat Portland cement, as specified in Japan Industrial Standard (JIS) R 5210. Of these, the Portland cement is preferably ordinary Portland cement and/or high-early-strength Portland cement in order to improve the strength development properties of the mortar for plastering.

[0010] (ii) Fly ash

The fly ash used in the present invention satisfies all of conditions (F1) to (F5) below.

(F1) The Blaine specific surface area of the fly ash is 2500 to 6000 cm²/g

(F2) The mass reduction rate of the fly ash is 5 mass% or less after the fly ash is heated for 15 minutes at a temperature of $975 \pm 25^{\circ}\text{C}$

(F3) The content of SiO_2 in the fly ash is 50 mass% or more

(F4) In the fly ash, the sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed is 2800 to 11,000 cm^2/cm^3

(F5) In the fly ash, the sphere equivalent specific surface area of amorphous particles containing Ca is 2100 to 22,500 cm^2/cm^3

[0011] Detailed explanations will now be given of conditions (F1) to (F5).

(F1): If the Blaine specific surface area of the fly ash is less than 2500 cm^2/g , the strength development properties of the mortar for plastering deteriorate, and if the Blaine specific surface area of the fly ash exceeds 6000 cm^2/g , the workability of the mortar for plastering deteriorates, and it is also difficult to procure fly ash having a Blaine specific surface area of more than 6000 cm^2/g . Moreover, the Blaine specific surface area is preferably 2700 to 5000 cm^2/g , and more preferably 2900 to 4000 cm^2/g .

[0012] (F2): If the mass reduction rate of the fly ash exceeds 5 mass% after the fly ash is heated for 15 minutes at a temperature of $975 \pm 25^{\circ}\text{C}$, the strength development properties of the mortar for plastering deteriorate. Moreover,

this mass reduction rate is preferably 1.0 to 4.5 mass%, and more preferably 1.5 to 4.0 mass%, from the perspectives of ease of procurement and strength development properties.

[0013] (F3): If the content of SiO_2 in the fly ash is less than 50 mass%, the strength development properties of the mortar for plastering deteriorate. Moreover, the content of SiO_2 is preferably 51 to 70 mass%, and more preferably 52 to 65 mass%, from the perspectives of ease of procurement and strength development properties.

[0014] (F4): In the fly ash, if the sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed falls outside the range 2800 to 11,000 cm^2/cm^3 , there are concerns that the workability and strength development properties of the mortar for plastering will deteriorate and that the amount of dripping will increase, and procurement is also difficult. Moreover, the sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed is preferably 4000 to 10,000 cm^2/cm^3 , and more preferably 5000 to 10,000 cm^2/cm^3 .

[0015] (F5): In the fly ash, if the sphere equivalent specific surface area of amorphous particles containing Ca falls outside the range 2100 to 22,500 cm^2/cm^3 , there are concerns that the workability and strength development properties of the mortar for plastering will deteriorate and that the amount of dripping will increase, and procurement is also difficult. Moreover, the sphere equivalent specific

surface area of amorphous particles containing Ca is preferably 4000 to 20,000 cm²/cm³, and more preferably 7000 to 20,000 cm²/cm³.

[0016] In addition, in order to improve the workability, and especially movement and spreadability, and the strength development properties of the mortar for plastering, the sphere equivalent specific surface area of particles in the fly ash in which mullite and an amorphous substance are mixed is preferably 1900 to 9500 cm²/cm³, more preferably 3000 to 9000 cm²/cm³, and further preferably 4500 to 9000 cm²/cm³. For the same reasons, the sphere equivalent specific surface area of amorphous particles not containing Ca in the fly ash is preferably 2100 to 9000 cm²/cm³, more preferably 3000 to 8500 cm²/cm³, and further preferably 4500 to 8500 cm²/cm³.

[0017] In addition, fly ash generally contains 5 to 25 mass% of quartz, and the lattice volume of quartz in the fly ash used in the present invention is a value determined using the Rietveld analysis method, and is preferably 113.5 to 114.5 Å³. If the quartz lattice volume falls within the range mentioned above, the fluidity and strength development properties of the mortar for plastering are further improved. Moreover, the lattice volume of the quartz is more preferably 113.6 to 114.4 Å³, and further preferably 113.7 to 114.3 Å³. Rietveld analysis of quartz in the fly ash can be carried out on the basis of X-Ray diffraction charts of fly ash using, for example, analytical software (Topas ver. 2.1) produced by

Bruker and 331161 (Quartz) as crystal structure data (ICDD number).

In addition, the sphere equivalent specific surface area of quartz particles in the fly ash is preferably 1100 to 12,500 cm²/cm³, more preferably 2500 to 10,000 cm²/cm³, and further preferably 4000 to 10,000 cm²/cm³, in order to improve the workability, and especially movement and spreadability, and the strength development properties of the mortar for plastering.

[0018] Fly ash particles are classified into five types, namely (i) particles in which iron oxide and an amorphous substance are mixed, (ii) particles in which mullite and an amorphous substance are mixed, (iii) amorphous particles not containing Ca, (iv) amorphous particles containing Ca, and (v) quartz particles, by means of steps (1) to (4) below.

(1) Sample preparation step

This step is a step in which a test piece is prepared by mixing fly ash and a resin and then curing. By dispersing the fly ash in the resin, fly ash particles do not overlap, and individual particles can be precisely extracted and measured in terms of property values in the particle analysis described later.

The resin should be one in which shrinkage is low during a curing step and which does not undergo cracking, and examples thereof include epoxy resins, acrylic resins, polyester resins methacrylic resins and the like. The mixing

proportion of the resin is preferably 0.8 to 4 relative to the fly ash in terms of volume ratio. If the mixing proportion of the resin falls within this range, multiple particles can be dispersed without coming into contact with each other, and it is possible to obtain cross sections of multiple particles by carrying out the polishing described below.

[0019] Next, an imaging surface of a cured test piece is polished. If unevenness occurs on the imaging surface or a cross section of a particle cannot be adequately obtained, it is not possible to accurately measure the particle diameter or shape of the particle, and precision in the particle analysis described later deteriorates.

The apparatus used for polishing the imaging surface of the test piece is not particularly limited, and a commonly used polishing apparatus can be used. In addition, the polishing material used in the polishing step is not particularly limited, and examples thereof include silicon carbide polishing materials, boron carbide polishing materials, diamond pastes and alumina powders. In addition, the polishing mentioned above is preferably buff polishing using an alumina powder or the like having a particle diameter of 0.3 to 3 μm as a polishing material, and is more preferably carried out using a cross section polisher using an argon ion beam in order to ensure that little unevenness occurs on the imaging surface.

[0020] Finally, a vapor deposited film is formed on the surface of the test piece whose imaging surface has been polished, thereby imparting the test piece with electrical conductivity. In the particle analysis described later, the test piece is irradiated with an electron beam, but because the fly ash and the resin are not electrically conductive, if a backscattered electron image is obtained without forming a vapor deposited film on the test piece, the surface of the test piece becomes electrically charged and an accurate backscattered electron image cannot be obtained. Therefore, an electrically conductive vapor deposited film is formed on the surface of the test piece in order to obtain an accurate backscattered electron image.

The vapor deposited film is not particularly limited as long as this film can impart the surface of the test piece with electrical conductivity, and examples thereof include vapor deposited films of carbon, platinum, palladium, gold, and the like. In addition, the method for forming the vapor deposited film is not particularly limited, and a well-known method can be used.

[0021] (2) Fly ash particle analysis step

This step is a step in which a backscattered electron image (BSE) and a chemical composition are obtained using an electron microscope from the test piece prepared in the sample preparation step above. Because the electron microscope should be one capable of giving a backscattered electron image

and measuring the chemical composition of extremely small regions, it is possible to use a scanning electron microscope (SEM), an electron-beam microanalyzer (EPMA), or the like. In the backscattered electron image, brightness increases as the average atomic number of elements that constitute this region increases. Examples of apparatuses for obtaining chemical compositions include wavelength dispersion type X-Ray spectrometers (WDS) and energy dispersion type X-Ray spectrometers (EDS), but it is preferable to use an energy dispersion type X-Ray spectrometer (EDS) in order to be able to obtain a chemical composition in a short time.

In order to obtain a backscattered electron image having a high resolution, it is preferable for the accelerating voltage to be approximately 10 to 15 keV, the irradiation current to be approximately 200 to 1000 pA, and the observation magnification to be 500 to 2000 times.

[0022] When subjecting the fly ash to particle analysis, a backscattered electron image is obtained from the fly ash test piece, and a threshold value of brightness at which is possible to separate fly ash particles from the resin is determined by visually comparing the brightness with a backscattered electron image of the fly ash particles and the resin and referring to brightness histograms. In addition, fly ash particles are extracted by binarization using the threshold value. Geometrical measurement values are measured for individual extracted fly ash particles. These geometrical

measurement values include coefficient of circularity, circle-equivalent diameter (the diameter of a circle having an area equivalent to the cross sectional area of the particle), aspect ratio and the like.

[0023] (3) Fly ash particle chemical analysis step

This step is a step in which the chemical composition of the fly ash is determined through chemical analysis of fly ash particles. In order to rapidly obtain the chemical composition of the fly ash with high precision using an energy dispersion type X-Ray spectrometer, the accelerating voltage is approximately 10 to 15 keV, the irradiation current is approximately 200 to 1000 pA, and the analysis time is 5 to 10 seconds per analysis point. In addition, the analysis region size is preferably the whole of an individual particle.

Moreover, the order in which chemical analysis is carried out and geometrical measurement values are measured is not limited. In addition, the number of fly ash particles to be measured is preferably 1000 particles or more, and more preferably 2000 particles or more, in order to reduce measurement errors in the chemical analysis and the geometrical measurement values. In addition, the X-Ray count per particle is preferably 5000 or more, more preferably 10,000 or more, and further preferably 100,000 or more. For image processing reasons in the particle analysis, particles split at the edge of the image are joined together during the analysis and counted as one particle. In addition, the area

and chemical composition of particles are determined as characters per particle.

[0024] (4) Fly ash particle classification step

This step is a step in which particles are classified into one of (i) particles in which iron oxide and an amorphous substance are mixed, (ii) particles in which mullite and an amorphous substance are mixed, (iii) amorphous particles not containing Ca, (iv) amorphous particles containing Ca, and (v) quartz particles, using the chemical composition of the fly ash particles and threshold values for the chemical composition of fly ash particles shown in Table 1. Moreover, extraction, chemical analysis and calculation of geometrical measurement values of fly ash particles to be subjected to classification can be measured automatically and easily using particle analysis software supplied with the electron microscope.

[0025]

[Table 1]

Classification	Chemical composition of fly ash particles				
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	SiO ₂ + Al ₂ O ₃
(i)	-	-	≥25	-	<50
(ii)	-	≥25	-	<50	≥50
(iii)	-	<25	-	<10	≥50
(iv)	-	<25	-	≥10	≥50
(v)	≥95	-	-	-	-

Note: SiO₂ + Al₂O₃ represents a simulated glass phase.

[0026] Sphere equivalent specific surface area is calculated in the following way.

First, it is assumed that all the classified fly ash particles are spheres, and the circle-equivalent diameter D is

calculated from the cross sectional area S of a fly ash particle using formula (1) below.

$$D = \sqrt{\frac{4 \times S}{\pi}} \quad \cdot \cdot \cdot (1)$$

Next, on the assumption that a particle is a sphere, the surface area A and volume V of a particle are calculated from the calculated circle-equivalent diameter using formula (2) and formula (3).

$$A = \pi D^2 \quad \cdot \cdot \cdot (2)$$

$$V = \frac{\pi D^3}{6} \quad \cdot \cdot \cdot (3)$$

Finally, the sum of the volumes and the sum of the surface areas of the classified fly ash particles are calculated, and the sphere equivalent specific surface area S_A is calculated using formula (4).

$$S_A = \frac{\sum_{i=1}^n A_n}{\sum_{i=1}^n V_n} \quad \cdot \cdot \cdot (4)$$

[0027] In order to improve the workability and strength development properties of the mortar for plastering and suppress dripping, the $(\text{Na}_2\text{O} + 0.658 \times \text{K}_2\text{O}) / (\text{MgO} + \text{SO}_3 + \text{TiO}_2 + \text{P}_2\text{O}_5 + \text{MnO})$ mass ratio in the fly ash is preferably 0.2 to 1.0,

more preferably 0.25 to 0.8, further preferably 0.28 to 0.7, and particularly preferably 0.3 to 0.6.

In addition, in order to improve the workability and strength development properties of the mortar for plastering, the compaction density of the fly ash, as calculated through measurements using the method described below, is preferably 1.0 to 1.5 cm³/g, more preferably 1.05 to 1.45 cm³/g, and further preferably 1.1 to 1.4 cm³/g.

[Method for measuring compaction density]

Using a PT-D powder tester produced by Hosokawa Micron Corp., compaction density is calculated by filling a 100 cm³ cup with fly ash while tapping the cup 180 times over a period of 180 seconds, and then measuring the mass of fly ash compacted in the cup. Moreover, the volume (denominator) used in the formula above for calculating density is the capacity of the cup.

[0028] Furthermore, the cement composition for plastering of the present invention may further contain blast furnace slag powder in order to improve the long-term strength development properties of the mortar for plastering.

In cases where the cement composition for plastering of the present invention contains blast furnace slag powder, the content of the blast furnace slag powder is preferably 50 mass% or less, and more preferably 45 mass% or less, when the total amount of the fly ash, the Portland cement and the blast furnace slag powder is taken to be 100 mass%. If the content

of the blast furnace slag powder exceeds 50 mass%, the long term strength development properties improvement effect of the mortar for plastering decreases.

Moreover, the Blaine specific surface area of the blast furnace slag powder is preferably 3000 to 6000 cm²/g, and more preferably 3300 to 5000 cm²/g, in order to improve the strength development properties of the mortar for plastering.

[0029] The cement composition for plastering of the present invention may further contain an inorganic powder obtained by pulverizing natural rock, such as limestone powder silica stone powder or the like, in order to improve the workability, and especially release properties and spreadability, of the mortar for plastering. Of these, the inorganic powder is preferably limestone powder.

In cases where the cement composition for plastering of the present invention contains an inorganic powder, the content of the inorganic powder is preferably 30 mass% or less, and more preferably 25 mass% or less, when the total amount of the fly ash, the Portland cement, the blast furnace slag powder and the inorganic powder is taken to be 100 mass%. If the content of the inorganic powder exceeds 30 mass%, there are concerns that the strength development properties of the mortar for plastering will deteriorate and that the amount of dripping will increase.

Moreover, the Blaine specific surface area of the inorganic powder is preferably 3000 to 10,000 cm²/g, and more

preferably 4000 to 8000 cm²/g, in order to improve the workability and strength development properties of the mortar for plastering.

[0030] In order to improve the strength development properties of the mortar for plastering of the present invention, the cement composition for plastering of the present invention may further contain one or more types of gypsum selected from among anhydrous gypsum, gypsum hemihydrate and gypsum dihydrate.

In cases where the cement composition for plastering of the present invention contains gypsum, the content of the gypsum is 3.0 mass% or less in terms of SO₃ when the total amount of the fly ash, the Portland cement, the blast furnace slag powder, the inorganic powder and the gypsum is taken to be 100 mass%. If the content of the gypsum exceeds 3.0 mass% in terms of SO₃, the fluidity of the mortar for plastering decreases. Moreover, the content of the gypsum in terms of SO₃ is more preferably 2.7 mass% or less, further preferably 2.5 mass% or less, and particularly preferably 2.3 mass% or less.

The gypsum is preferably anhydrous gypsum or gypsum dihydrate in order to improve the strength development properties of the mortar for plastering. In addition, the Blaine specific surface area of the gypsum is preferably 3000 to 15,000 cm²/g, and more preferably 3500 to 13,000 cm²/g, in order to improve strength development properties.

[0031] 2. Mortar for plastering

An explanation will now be given of the mortar for plastering of the present invention.

The mortar for plastering of the present invention contains the cement composition for plastering mentioned above, fine aggregate and water.

Examples of the fine aggregate include river sand, mountain sand, inland sand, beach sand, crushed sand, silica sand mixtures of these and the like.

The blending quantity of the fine aggregate is preferably 150 to 800 parts by mass, more preferably 175 to 750 parts by mass, further preferably 200 to 500 parts by mass, and particularly preferably 200 to 300 parts by mass, relative to 100 parts by mass of the cement composition for plastering. If this blending quantity is 150 parts by mass or more, the strength development properties of the mortar for plastering are improved, and if this blending quantity is 800 parts by mass or less, the workability of the mortar for plastering is improved.

[0032] Tap water or the like can be used as the water. The blending quantity of the water is preferably 40 to 125 parts by mass, more preferably 45 to 120 parts by mass, further preferably 50 to 100 parts by mass, and particularly preferably 50 to 80 parts by mass, relative to 100 parts by mass of the cement composition for plastering. If this blending quantity is 40 parts by mass or more, the workability

of the mortar for plastering is improved, and if this blending quantity is 125 parts by mass or less, the strength development properties of the mortar for plastering are improved.

Working Examples

[0033] The present invention will now be explained in greater detail through the use of working examples, but is not limited to these working examples.

1. Materials used

Materials used in samples are as follows.

(1) Ordinary Portland cement

Blaine specific surface area 3310 cm²/g, produced by Taiheiyo Cement Corporation.

(2) Gypsum dihydrate

Blaine specific surface area 8250 cm²/g, produced by Sumitomo Metal Industries.

(3) Blast furnace slag powder

Blaine specific surface area 4300 cm²/g, produced by DC CO., LTD.

(4) Limestone powder

Blaine specific surface area 6500 cm²/g, produced by Yuko Kogyo Kabushiki Kaisha.

(5) Fine aggregate

No. 5 silica sand.

(6) Water

Tap water.

In addition, characteristics of fly ash (FA) used in samples are shown in Table 2 and Table 3.

Moreover, FA1 to FA7 satisfy all of conditions (F1) to (F5) above, but FA8 to FA12 do not satisfy some of these conditions. Furthermore, FA1 does not satisfy condition (F6) and FA2 does not satisfy condition (F7), but FA3 to FA6 satisfy both (F6) and (F7). In addition, the sphere equivalent specific surface area of quartz particles in FA7 falls outside the range 1100 to 12,500 cm²/cm³.

[0034]

[Table 2]

Type of fly ash	Blaine specific surface area (cm ² /g)	Mass reduction rate (mass%)	SiO ₂ content (mass%)	Fe-G (cm ² /cm ³)	CAS (cm ² /cm ³)
FA1	3880	3.1	57.3	7690	4100
FA2	3840	3.1	56.7	7780	4280
FA3	3800	3.2	58.5	7560	4200
FA4	3660	3.4	54.8	5630	18,160
FA5	3340	2.2	63.1	7680	11,820
FA6	3020	3.7	58.3	10,560	14,290
FA7	3500	2.5	51.3	3430	7360
FA8	2300	2.9	53.3	6320	5810
FA9	3160	7.2	53.8	7350	5300
FA10	3360	4.2	46.8	7410	4400
FA11	3740	3.3	60.3	3520	1570
FA12	3810	3	59.6	2250	19,700

Note: Fe-G indicates the sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed.

Note: CAS indicates the sphere equivalent specific surface area of amorphous particles containing Ca.

[0035]

[Table 3]

Type of fly ash	M-G (cm ² /cm ³)	AS (cm ² /cm ³)	Q (cm ² /cm ³)
FA1	1300	8860	8600
FA2	8840	9430	9120
FA3	3260	4560	3830
FA4	4660	7630	8160
FA5	7340	7680	7700
FA6	9020	8560	4200
FA7	3500	3430	16,000

Note: M-G indicates the sphere equivalent specific surface area of particles in which mullite and an amorphous substance are mixed.

Note: AS indicates the sphere equivalent specific surface area of amorphous particles not containing Ca.

Note: Q indicates the sphere equivalent specific surface area of quartz particles.

[0036] 2. Production of cement compositions for plastering

Cement compositions for plastering were produced by mixing fly ash (FA), cement (C), and limestone powder (LS), blast furnace slag powder (BS) and gypsum powder (GG) as optional components according to cement composition formulations shown in Table 4.

Moreover, values for GG in Table 4 are in terms of SO₃.

[0037]

[Table 4]

	Cement composition					
	Type of FA	FA (mass%)	C (mass%)	LS (mass%)	BS (mass%)	GG (mass%)
Working Example 1	FA1	30	70	-	-	-
Working Example 2	FA2	30	70	-	-	-
Working	FA3	30	70	-	-	-

Example 3						
Working Example 4	FA4	30	70	-	-	-
Working Example 5	FA5	30	70	-	-	-
Working Example 6	FA6	30	70	-	-	-
Working Example 7	FA7	30	70	-	-	-
Working Example 8	FA3	30	60	10	-	-
Working Example 9	FA3	15	65	20	-	-
Working Example 10	FA3	30	60	-	10	-
Working Example 11	FA3	15	82.7	-	-	2.3
Working Example 12	FA1	15	85	-	-	-
Working Example 13	FA2	15	85	-	-	-
Working Example 14	FA3	15	85	-	-	-
Working Example 15	FA4	15	85	-	-	-
Working Example 16	FA5	15	85	-	-	-
Comparative Example 1	-	100		-	-	-
Comparative Example 2	FA8	30	70	-	-	-
Comparative Example 3	FA9	30	70	-	-	-
Comparative Example 4	FA10	30	70	-	-	-
Comparative Example 5	FA11	30	70	-	-	-
Comparative Example 6	FA12	30	70	-	-	-
Comparative Example 7	FA3	5	95	-	-	-
Comparative Example 8	FA3	60	40	-	-	-

[0038] 2. Production of mortar for plastering

At an environment temperature (ambient temperature) of 27°C, 10 kg of the cement composition and 20 kg of silica sand were placed in a pan type mortar mixer (produced by Mazelar Co., Ltd.) and dry mixed for 1 minute. Next, the mixture was kneaded for 1 minute while introducing 4.0 kg of water, which corresponds to approximately 80% of the total amount of water.

Following the kneading, a mortar for plastering was obtained by scraping off kneaded matter attached to the side wall of the mixer, and then kneading for 3 minutes while introducing 1.1 kg of water, which corresponds to approximately 20% of the total amount of water.

[0039] 2. Tests

(A) Workability evaluation test

At an environment temperature of 27°C, the mortar for plastering was applied at a thickness of approximately 2 cm to surfaces of a calcium silicate board, which had a height of 910 mm and a width of 1820 mm and was disposed so as to extend in a vertical direction, and a lightweight mortar wall, which was similarly disposed and had the same dimensions, and the mortar was then subjected to the following evaluations.

(1) Evaluation of lack of mortar dripping

The mortar was applied to the surfaces mentioned above and then allowed to stand for 1 hour at 27°C. After standing, it was evaluated whether or not the applied mortar for plastering had dripped or separated.

(2) Evaluation of mortar movement

When the mortar was applied to the surfaces mentioned above and the mortar surface was smoothed with a trowel, the lack of movement of the mortar at the periphery of the smoothed region was evaluated. Moreover, cases where the mortar hardly moved (was stable) at the periphery of the

smoothed region in the movement evaluation was evaluated highly.

(3) Evaluation of mortar spreadability

When the mortar was applied to the surfaces mentioned above, it was evaluated whether or not the mortar had little resistance and could be spread easily.

(4) Evaluation of trowel release properties

After the mortar for plastering was applied to the surfaces mentioned above, it was evaluated whether or not the mortar stuck to the trowel when the trowel was removed from the applied surfaces.

Moreover, the evaluations mentioned above were carried out using scores of 0 to 5.5, with a higher score indicating a better evaluation.

In the results shown in Table 5, lack of mortar dripping is shown by "Dripping", mortar movement is shown by "Movement", mortar spreadability is shown by "Spreadability", and trowel release properties are shown by "Release properties".

(B) Compressive strength test

Compressive strength at a material age of 28 days was measured in accordance with JIS R 5201. These results are shown in Table 5.

[0040]

[Table 5]

	Type of FA	Drippin g	Movemen t	Spreadabilit y	Removal propertie s	Compressiv e strength (N/mm ²)
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Working Example 1	FA1	4	4	4.5	4.5	49.7
Working Example 2	FA2	4	4	4.5	4.5	50.3
Working Example 3	FA3	4	4	4.5	4.5	49.5
Working Example 4	FA4	4	4	4.5	4.5	51.2
Working Example 5	FA5	4	4	4	4	50.7
Working Example 6	FA6	4	4	4	4	51.6
Working Example 7	FA7	4	4	4.5	4.5	49.5
Working Example 8	FA3	4.5	4.5	5	4.5	50.8
Working Example 9	FA3	5	4.5	4.5	4	47.5
Working Example 10	FA3	4.5	4.5	4.5	4.5	51.7
Working Example 11	FA3	5	4	4.5	4	58.3
Working Example 12	FA1	4	4	4	4	58.7
Working Example 13	FA2	4	4	4	4	59.3
Working Example 14	FA3	4	4	4	4.5	58.2
Working Example 15	FA4	4	4	4	4	60.1
Working Example 16	FA5	4	4	4	4	59
Comparative Example 1	-	2.5	2	2	2.5	63.7
Comparative Example 2	FA8	3.5	3	3	3	46.7
Comparative Example 3	FA9	4	3.5	3	2.5	45.7
Comparative Example 4	FA10	3.5	3.5	3	3	45.3
Comparative Example 5	FA11	4	4	4.5	4.5	44.7
Comparative Example 6	FA12	4	4	4.5	4.5	45
Comparative Example 7	FA3	2.5	3	2.5	3	60.8
Comparative Example 8	FA3	3	4	4	4	22.3

[0041] As shown in Table 5, mortars obtained using the cement composition for plastering of the present invention (Working Examples 1 to 16) were evaluated highly in terms of movement, spreadability and release properties at an environment temperature of 27°C, exhibited excellent

workability, caused little dripping after being applied to a wall, and exhibited high strength development properties.

Conversely, mortars obtained using the cement compositions of Comparative Examples 1 to 8 were evaluated poorly in terms of movement, spreadability and release properties at an environment temperature of 27°C, exhibited poor workability, caused dripping after being applied to a wall, and exhibited low strength development properties.

[CLAIMS]

[Claim 1]

A cement composition for plastering, containing at least fly ash that satisfies all of conditions (F1) to (F6) below and Portland cement, wherein a content of the fly ash is 10 to 50 mass% when a total amount of the fly ash and the Portland cement is 100 mass%:

(F1) a Blaine specific surface area of the fly ash is 2500 to 6000 cm²/g;

(F2) a mass reduction rate of the fly ash is 5 mass% or less after the fly ash is heated for 15 minutes at a temperature of 975 ± 25°C;

(F3) a content of SiO₂ in the fly ash is 50 mass% or more;

(F4) in the fly ash, a sphere equivalent specific surface area of particles in which iron oxide and an amorphous substance are mixed is 2800 to 11,000 cm²/cm³;

(F5) in the fly ash, a sphere equivalent specific surface area of amorphous particles containing Ca (calcium) is 2100 to 22,500 cm²/cm³;

(F6) in the fly ash, a sphere equivalent specific surface area of particles in which mullite and an amorphous substance are mixed is 1900 to 9500 cm²/cm³.

[Claim 2]

The cement composition for plastering according to claim 1, wherein the fly ash also satisfies condition (F7) below:

(F7) in the fly ash, a sphere equivalent specific surface area of amorphous particles not containing Ca is 2100 to 9000 cm^2/cm^3 .

[Claim 3]

The cement composition for plastering according to any one of claim 1 or claim 2, further containing blast furnace slag powder, wherein a content of the blast furnace slag powder is 50 mass% or less when a total amount of the Portland cement, the fly ash and the blast furnace slag powder is 100 mass%.

[Claim 4]

The cement composition for plastering according to any one of claims 1 to 3, further containing an inorganic powder obtained by pulverizing natural rock, wherein a content of the inorganic powder is 30 mass% or less when a total amount of the Portland cement, the fly ash, the blast furnace slag powder and the inorganic powder is 100 mass%.

[Claim 5]

The cement composition for plastering according to any one of claims 1 to 4, further containing one or more types of gypsum selected from among anhydrous gypsum, gypsum hemihydrate and gypsum dihydrate, wherein a content of the gypsum is 3.0 mass% or less in terms of SO_3 when a total amount of the Portland cement, the fly ash, the blast furnace slag powder, the inorganic powder and the gypsum is 100 mass%.

[Claim 6]

A mortar for plastering comprising the cement composition for plastering according to any one of claims 1 to 5, fine aggregate and water.