

DESCRIPTION

CEMENT COMPOSITION

TECHNICAL FIELD

The present invention relates to a cement
5 composition which is to be used mainly in the field of
civil engineering and construction.

Part(s) and % used in the present specification are
based on mass unless otherwise specified.

BACKGROUND ART

10 In recent years, environmental problems have been
elicited, and reduction in environmental impact has been
required in each field.

As the proportion of the amount of carbon dioxide
discharged in the field of civil engineering and
15 construction is extremely high based on that in the
entire industries, reduction of environmental impact has
been eagerly desired particularly in the field of civil
engineering and construction.

Most of carbon dioxide discharged in the cement
20 industry is derived from calcination of limestone as a
material and burning of fuel used at the time of
calcination.

Accordingly, in order to reduce the carbon dioxide
emission, it is the most effective method to reduce the
25 amount of calcination of cement clinker, and it is
extremely important to promote use of various blended
cements having various admixtures mixed therewith with a

reduced amount of cement.

However, there has been such a problem that the blended cement is poor in initial strength-development.

The initial strength is deeply relevant to the
5 release cycle and therefore is important in order to shorten the time for construction, and at present, development of a cement composition which provides favorable initial strength-development, particularly strength-development equal to that of ordinary Portland
10 cement even when an admixture is used in an amount exceeding 30%, has been desired.

On the contrary, a slowly cooled blast furnace slag formed as a by-product in a steel plant, is utilized for a roadbed material or a cement material, however, the
15 amount treated is very slight relative to the amount generated, and its effective use has been in search yet.

Accordingly, the present inventors have been conducted extensive studies to overcome the above problems and as a result, they have found that favorable
20 initial strength-development can be obtained by use of a cement composition containing Portland cement having a $3\text{CaO}\cdot\text{SiO}_2$ content of at least 60% and a slowly cooled blast furnace slag powder, and particularly, a cement composition using a slowly cooled blast furnace slag
25 powder in an amount of from 10 to 50% provides strength-development equal to that of ordinary Portland cement. The present invention has been accomplished on the basis

of these discoveries.

DISCLOSURE OF THE INVENTION

Namely, the present invention provides a cement composition containing Portland cement having a $3\text{CaO}\cdot\text{SiO}_2$ content of at least 60% and a slowly cooled blast furnace slag powder, and the cement composition wherein the content of the slowly cooled blast furnace slag powder is from 10 to 50 parts per 100 parts of the cement composition.

10 BEST MODE FOR CARRYING OUT THE INVENTION

Now, the present invention will be explained in further detail.

The Portland cement having a $3\text{CaO}\cdot\text{SiO}_2$ (hereinafter referred to as C_3S) content of at least 60% (hereinafter sometimes referred to as a cement substance) used in the present invention is one having a C_3S content of at least 60%, and contents of $3\text{CaO}\cdot\text{Al}_2\text{O}_3$, $4\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot\text{Fe}_2\text{O}_3$, $2\text{CaO}\cdot\text{SiO}_2$ and gypsum are not particularly limited. As the Portland cement, a mixture of at least two types of Portland cements having different compositions may be used, and in such a case, the C_3S content represents the weighted average of the C_3S contents of the respective Portland cements contained in the mixture.

In general, the Portland cement is composed of clinker mainly composed of C_2S , C_3S , C_3A and C_4AF , and gypsum, where CaO , SiO_2 , Al_2O_3 and Fe_2O_3 are represented as C, S, A and F, respectively.

As the cement substance, use of high-early-strength cement or ultra high-early-strength cement is preferred, and they are available as commercial products.

The particle size of the cement substance is not particularly limited, but is usually preferably at a level of from 3,000 to 8,000 cm^2/g as the Blaine specific surface area value (hereinafter referred to as Blaine value). If it is less than 3,000 cm^2/g , such an effect of the present invention that the initial strength-development equal to that of ordinary Portland cement is obtained may not be obtained in some cases, and even when the cement substance is ground to obtain a Blaine value of 8,000 cm^2/g , no further increase of the effect can be expected. The above Blaine value is particularly preferably from 3,500 to 6,000 cm^2/g .

The slowly cooled blast furnace slag powder (hereinafter referred to as slowly cooled slag) used in the present invention is a blast furnace slag crystallized by air-cooling. The slowly cooled slag is obtained usually by pouring molten slag to a cooling yard called dry pit or field, followed by cooling by air cooling and appropriate water spray, and is obtained as crystalline block slag.

The proportion of chemical components in the slowly cooled slag is not particularly limited, but in general, SiO_2 is from 25 to 45%, CaO is from 30 to 50%, Al_2O_3 is from 10 to 20%, and MgO is from 3 to 10%, which are the

main components. In addition, Na_2O , K_2O , Fe_2O_3 , MnO , TiO_2 , S and the like are contained in an amount of at most 2%, respectively, which are trace constituents.

The Blaine value of the slowly cooled slag preferably exceeds $4,000 \text{ cm}^2/\text{g}$, it is more preferably at least $4,500 \text{ cm}^2/\text{g}$, most preferably at least $5,000 \text{ cm}^2/\text{g}$. If the Blaine value is at most $4,000 \text{ cm}^2/\text{g}$, no effect of suppressing the bleeding may be obtained in some cases. On the other hand, if said Blaine value is excessively high, the amount of water kneaded tends to be large, and the strength-development and durability tend to be poor in some cases, and it is preferably at most $8,000 \text{ cm}^2/\text{g}$.

Further, the percentage of glass content of the slowly cooled slag is not particularly limited, but it is usually at most 30%, preferably at most 10%. If the percentage of glass content exceeds 30%, the heat release value tends to be high in some cases.

The percentage of glass content (X) in the present invention is obtained from the formula $X(\%) = (1 - S/S_0) \times 100$. S is the area of the main peak of melilite (a solid solution of gehlenite $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2$ and akermanite $2\text{CaO} \cdot \text{MgO} \cdot 2\text{SiO}_2$) which is a main crystalline compound in the slowly cooled slag, as obtained by a powder X-ray diffraction method, and S_0 represents the area of the main peak of melilite, with respect to the slowly cooled slag heated at $1,000^\circ\text{C}$ for 3 hours and then cooled at a cooling rate of $5^\circ\text{C}/\text{min}$.

The components of the slowly cooled slag are similar to the composition of the granulated blast furnace slag, and specifically, SiO_2 , CaO , Al_2O_3 , MgO and the like are main chemical components, and further, TiO_2 , MnO , Na_2O ,
5 S, Cr_2O_3 , P_2O_5 , Fe_2O_3 and the like are mentioned.

Further, in a case of preparation of the slowly cooled slag, it may be granulated simultaneously with grinding of the clinker in the cement substance, or they may be granulated separately.

10 The amount of the slowly cooled slag used is not particularly limited, but usually it is preferably from 10 to 50 parts, more preferably from 30 to 40 parts, per 100 parts of the cement composition comprising Portland cement having a C_3S content of at least 60% and a slowly
15 cooled slag. If it is less than 10 parts, reduction of environmental impact tends to be insufficient, and if it exceeds 50 parts, the strength-development tends to be poor in some cases.

The particle size of the cement composition of the
20 present invention depends on the purpose of use and application and thus it is not particularly limited, but usually it is preferably from 3,000 to 8,000 cm^2/g , more preferably from 4,000 to 6,000 cm^2/g as the Blaine value. If it is less than 3,000 cm^2/g , no adequate strength-
25 development may be obtained in some cases, and if it exceeds 8,000 cm^2/g , workability tends to be poor in some cases.

To prepare the cement composition of the present invention, the respective materials may be mixed at the time of application or may be preliminarily mixed.

In the present invention, an aggregate such as sand
5 or ballast, a reinforcing fiber material, a water
reducing agent, a high-range water reducing agent, a
high-range AE water reducing agent, a thickner, a cement
expanding agent, an antirust, an antifreezing agent, a
clay mineral such as bentonite or montmorillonite, an
10 ion-exchanger such as zeolite, hydrotalcite or
hydrocalumite, fly ash, limestone powder, a granulated
blast furnace slag fine powder, silica fume or the like,
may be used, in addition to the cement composition,
within a range not to substantially hinder the purpose of
15 the present invention.

Now, the present invention will be explained in
detail with reference to Examples.

EXPERIMENT EXAMPLE 1

With 100 parts of a cement composition comprising a
20 cement substance and a slowly cooled slag as identified
in Table 1, 50 parts of water and 300 parts of sand were
mixed to prepare mortar, and the compressive strength was
measured. The results are also shown in Table 1.

Materials used

25 Cement substance A: ordinary Portland cement (CaO:
65.29%, SiO₂: 22.14%, Al₂O₃: 4.91%, Fe₂O₃: 2.96%, SO₃:
1.86%), C₃S content: 55%

Cement substance B: high-early-strength Portland cement (CaO: 66.87%, SiO₂: 22.34%, Al₂O₃: 4.11%, Fe₂O₃: 2.30%, SO₃: 2.33%), C₃S content: 65%

Cement substance C: a mixture comprising 50 parts of
5 the cement substance A and 50 parts of the cement substance B, C₃S content: 60%

Slowly cooled slag: granulated product of slowly cooled blast furnace slag (CaO: 39.50%, SiO₂: 31.70%, Al₂O₃: 14.80%, MgO: 7.20%), Blaine value: 4,500 cm²/g,
10 specific gravity: 3.00, percentage of glass content: 2%

Sand: standard sand used in JIS R 5201

Water: running water

Measuring method

Compressive strength: measured in accordance with
15 JIS R 5201.

Table 1

Experiment No.	Cement substance		Slowly cooled slag content (parts)	Compressive strength (N/mm ²)			Note
	Type	Content (parts)		1 day	3 days	7 days	
1-1	A	100	0	10.5	23.0	41.0	Comp. Ex.
1-2	A	65	35	7.5	16.2	29.3	Comp. Ex.
1-3	B	65	35	13.3	26.4	44.9	Ex.
1-4	C	65	35	11.8	24.7	43.0	Ex.

EXPERIMENT EXAMPLE 2

The same operation as in Experiment Example 1 was carried out except that the cement substance B and the slowly cooled slag as identified in Table 2 were used.

5 The results are also shown in Table 2.

Table 2

Experiment No.	Cement substance		Slowly cooled slag content (parts)	Compressive strength (N/mm ²)			Note
	Type	Content (parts)		1 day	3 days	7 days	
2-1	B	100	0	21.9	40.3	53.2	Comp. Ex.
2-2	B	90	10	19.5	39.2	54.1	Ex.
2-3	B	80	20	18.3	36.2	51.3	Ex.
2-4	B	70	30	15.3	31.8	47.1	Ex.
1-3	B	65	35	13.3	26.4	44.9	Ex.
2-5	B	60	40	12.6	25.7	44.3	Ex.
2-6	B	50	50	11.6	24.9	43.2	Ex.

INDUSTRIAL APPLICABILITY

By using the cement composition of the present invention, initial strength-development equal to that of ordinary Portland cement can be obtained, and the clinker
5 calcination amount when Portland cement is calcined can be decreased, and accordingly the cement composition of an environmental impact reducing type can be obtained.

CLAIMS

1. A cement composition containing Portland cement having a $3\text{CaO}\cdot\text{SiO}_2$ content of at least 60% and a slowly cooled blast furnace slag powder,
5 wherein the above slowly cooled blast furnace slag powder is contained in an amount of from 10 to 50 parts in a total amount of 100 parts of the slowly cooled blast furnace slag powder and the above Portland cement.
2. The cement composition according to Claim 1, wherein
10 the particle size of the above Portland cement is from 3,000 to 8,000 cm^2/g as the Blaine specific surface area value.
3. The cement composition according to Claim 1 or 2, wherein the above slowly cooled blast furnace slag
15 contains, as the main components, from 25 to 45% of SiO_2 , from 30 to 50% of CaO , from 10 to 20% of Al_2O_3 and from 3 to 10% of MgO .
4. The cement composition according to any one of Claims 1 to 3, wherein the particle size of the above slowly
20 cooled blast furnace slag is at least 4,000 cm^2/g as the Blaine specific surface area value.
5. The cement composition according to any one of Claims 1 to 4, wherein the above slowly cooled blast furnace slag has a percentage of glass content of at
25 most 30%.