

SPECIFICATION

CEMENT MORTAR COMPOSITION FOR GROUT AND GROUT MORTAR OBTAINED FROM THE SAME

5

TECHNICAL FIELD

The present invention relates generally to a cement mortar composition for grouting purposes in the civil engineering and construction field, and more particularly to a grouting cement mortar composition having good fluidity, high strength, an increased robustness and low shrinkage, and a grout mortar using the same.

BACKGROUND OF THE INVENTION

15 General grout materials have comprised cement and a water-reducing agent added to it. In addition, an expanding material based on calcium sulfoaluminate or lime, and a foaming agent such as aluminum powders are added to the grout materials to keep them against shrinkage.

20 Besides, these are blended with river sand, silica sand or the like into pastes or mortars that are now widely used in engineering public works and construction works, and especially for the purpose of filling up fine pores in concrete structures and pores caused by the back pouring method, repairing and reinforcing structures, and being

25 filled under the base plate of machinery, the floor of tracks, and so on.

The grout materials now in use include PC grout, grout of prepacked concrete, grout for back-filling tunnels or shields, precasting grout, injection group for repairing and reinforcing structures, reinforced concrete joint grout, grout that is filled under the supports of

bridges, grout that is filled under the base plate of machinery, grout that is filled under pavement slabs, slab grout that is filled under tracks, and grout that is filled under atomic power plant containers.

5 Among grouting cement mortar compositions known so far in the art, there is the fast setting type containing a rapid-hardening agent (see Patent Publications 1-4). These grouting cement mortar compositions contain a setting regulator (setting retarder) and a fluidizing
10 agent (water-reducing agent) together with the rapid-hardening material, and Patent Publication 2 also teaches that a rapid-hardening agent comprising calcium aluminosilicate glass and calcium sulfate is used as that rapid-hardening material.

15 With these grouting cement mortar compositions, there is a grout mortar obtained that has the good ability to produce strength and makes sure constant fluidity; however, there is still mounting demand for a grouting cement mortar composition that can achieve high strength,
20 high robustness and low shrinkage without causing bleeding and segregation.

Patent Publication 1: JP(A) 2001-97759

Patent Publication 2: JP(A) 2006-27937

25 Patent Publication 3: JP(A) 2006-104013

Patent Publication 4: Patent No. 2861612

A cement admixture comprising as main ingredients calcium aluminosilicate glass, inorganic sulfates (calcium
30 sulfate) and reactive silica substances (finely pulverized pozzolan) is known too (see Patent Publication 5); however, Patent Publication 5 does not show that such a cement

admixture is used for grouting cement mortar compositions.

Patent Publication 5: Patent No. 2975422

5 On the other hand, there is also a mortar
composition known, which comprises cement, an expanding
agent and a binder containing finely pulverized pozzolan
with a fine aggregate (for instance, a heavy weight
aggregate having a specific weight of 3.0 or more) and a
10 water-reducing agent added to it, and is used primarily
for filling work at shielding walls of nuclear power
plants, the foundation structures of machinery or the like
(see Patent Publication 6). That publication alleges that
there can be a heavy weight mortar provided which has good
15 fluidity without segregation, and holds back temperature
rises, making temperature stress cracking less likely;
however, no reference is made to the application of such a
heavy weight mortar to the fast setting type of grout
mortar.

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Patent Publication 6: JP(A) 2005-47772

SUMMARY OF THE INVENTION

OBJECT OF THE INVENTION

25 An object of the invention is to provide a grouting
cement mortar composition that is well fit for use for
foundation grouts for machinery or the like among the
aforesaid multiple applications, keeps good fluidity and
achieves high strength, an increased robustness and low
30 shrinkage without giving rise to bleeding and segregation,
and a grout mortar using the same.

MEANS FOR ACCOMPLISHING THE OBJECT

According to the invention, the aforesaid object is accomplishable by the following embodiments.

(1) A grouting cement mortar composition
5 comprising a binder, a setting retarder, a water-reducing agent and a fine aggregate, characterized in that said binder contains a rapid-hardening material comprising cement, calcium aluminosilicate glass and calcium sulfate, and finely pulverized pozzolan; said water-reducing agent
10 contains at least a polycarboxylate base water-reducing agent; and said fine aggregate is a heavy weight aggregate having a density of 3.0 g/cm^3 or greater.

(2) The grouting cement mortar composition according to (1) above, characterized in that said finely
15 pulverized pozzolan is silica base fine powders having a silicon dioxide content of 90% or higher and having a hydrogen ion concentration lying in an acidic region.

(3) The grouting cement mortar composition according to (1) or (2) above, characterized in that said
20 cement contains classified, finely pulverized cement.

(4) The grouting cement mortar composition according to any one of (1) to (3) above, characterized in that said binder further contains an expanding agent.

(5) The grouting cement mortar composition
25 according to (4) above, characterized in that said expanding agent is a calcium sulfoaluminate base expanding agent having a Blaine's value of $4,000 \text{ cm}^2/\text{g}$ or greater.

(6) The grouting cement mortar composition according to any one of (1) to (5) above, characterized in
30 that said water-reducing agent further contains a melamine sulfonate base water-reducing agent.

(7) The grouting cement mortar composition

according to any one of (1) to (6) above, characterized by further containing a shrinkage-reducing agent.

(8) The grouting cement mortar composition according to any one of (1) to (7) above, characterized by
5 further containing a foaming substance.

(9) The grouting cement mortar composition according to any one of (1) to (8) above, characterized by further containing a viscosity-increasing agent.

(10) A grout mortar wherein the grouting cement
10 mortar composition according to any one of (1) to (9) above is kneaded with water.

(11) The grout mortar according to (10) above, wherein water is used in an amount of 31 to 36 parts per 100 parts of the binder.

15

ADVANTAGES OF THE INVENTION

By the use of the inventive grout composition, it is possible to provide grout mortar that gets hold of good fluidity, has high strength and an increased robustness
20 without giving rise to bleeding or segregation, and is capable of preventing cracking due to a decreased shrinkage on drying.

BEST MODE OF CARRYING OUT THE INVENTION

25 The present invention is now explained at great lengths.

Unless otherwise stated, the "parts" and "%" used herein are given on a mass basis.

In the invention, water is kneaded with the grouting
30 cement mortar composition that comprises cement, a rapid-hardening agent, finely pulverized pozzolan, a setting retarder, a water-reducing agent and a heavy weight

aggregate and may optionally an expanding agent, a shrinkage-reducing agent, finely pulverized cement, a foaming substance and a viscosity-increasing agent.

5 The cement used here, for instance, includes various Portland cements such as normal, high-early strength, low heat, and medium heat Portland cements as well as a waste recycle type cement: the so-called ecocement.

10 In the invention, finely pulverized cement may be used for a part of the cement. For the finely pulverized cement, normal Portland cement may be pulverized to a particle size of 20 μm or less and then classified to a particle size of 10 μm or less. The finely pulverized cement may be used in an amount of 5 parts or less per 100 parts of the binder (cement, rapid-hardening material, 15 finely pulverized pozzolan and expanding agent). As that amount grows greater than 5 parts, it causes the effect on holding back bleeding to get saturated and is often detrimental to fluidity.

20 The rapid-hardening material used herein comprises calcium aluminosilicate glass and calcium sulfate.

The calcium aluminosilicate glass used here should preferably have a composition region made up of 60 to 30% of CaO , 20 to 60% of Al_2O_3 and 5 to 25% of SiO_2 , and especially 55 to 30% of CaO , 30 to 60% of Al_2O_3 and 10 to 25 25% of SiO_2 . As CaO is short of 30% or Al_2O_3 is in excess of 60%, it is detrimental to rapid-hardening capability, and as CaO is in excess of 60% or Al_2O_3 is short of 20%, on the contrary, it causes instantaneous setting even with a large amount of the setting retarder added. As SiO_2 is 30 short of 5%, any increase in long-term strength is not expectable, and as it is in excess of 25%, on the contrary, there is a drop of the ability to produce initial strength.

Referring to the raw material for the calcium aluminosilicate glass used here, quick lime (CaO), slaked lime ($\text{Ca}(\text{OH})_2$), limestone (CaCO_3) or the like may be used for the CaO base material; alumina, bauxite, diaspore, feldspar, clay or the like may be used for the Al_2O_3 base material; and silica sand, white earth, diatomaceous earth or the like may be used for the SiO_2 base material.

The above CaO -, Al_2O_3 - and SiO_2 -base materials are blended together at a given proportion, and then melted directly in an electric melting furnace or high-frequency furnace, followed by blowing out the ensuing melt with compressed air or high-pressure water, or casting it in water. Alternatively, the raw materials may be molten and quenched in a rotary kiln.

In view of a problem with the ability to produce strength, the particle size of calcium aluminosilicate glass is preferably at least $3,000 \text{ cm}^2/\text{g}$, and more preferably at least $5,000 \text{ cm}^2/\text{g}$ in terms of the Blaine's value. At less than $3,000 \text{ cm}^2/\text{g}$, there may possibly be a drop of the ability to produce strength.

For the calcium sulfate, there is the mention of anhydrous gypsum, hemihydrate gypsum, gypsum or the like, which may be used alone or in combination of two or more. Of these, preference is given to anhydrous gypsum in view of the ability to produce strength.

In view of the ability to produce strength, the particle size of calcium sulfate is preferably at least $3,000 \text{ cm}^2/\text{g}$, and more preferably $5,000 \text{ cm}^2/\text{g}$ in terms of the Blaine's value. At less than $3,000 \text{ cm}^2/\text{g}$, there may possibly be a drop of the ability to produce strength.

The amount of the calcium sulfate used is preferably 50 to 150 parts per 100 parts of calcium aluminosilicate

glass. At less than 50 parts and at greater than 150 parts, there may possibly be a drop of the ability to produce strength.

5 The amount of the rapid-hardening material added is preferably 9 to 25 parts in 100 parts of the binder. At less than 9 parts, there may possibly be a drop of the ability to produce strength, and at greater than 25 parts, its effect gets saturated.

10 The finely pulverized pozzolan used here is to produce good fluidity and strength at low water ratios in particular, and for that, preference is given to a silica base fine powder having a silicon dioxide (SiO_2) content of at least 90% and a hydrogen ion concentration lying in an acidic region.

15 For instance, the silica base fine powders may be prepared by adjusting heat treatment conditions for the raw materials and keeping the collection temperature at 550°C or higher in a process wherein fine powders of metallic silicon are oxidized in flames, or fine powders
20 of the silica base raw material are melted in high-temperature flames. Alternatively, they may be prepared by electrically melting zircon sand in an electric furnace and collecting it a cyclone or the like, followed by classification.

25 The amount of the fine powders of pozzolan used is preferably 5 to 15 parts in 100 parts of the binder. At less than 5 parts, only insufficient strength is produced, or there is none of the ball bearing effect, which may otherwise increase loads on kneading, often failing to
30 obtain good fluidity in a given amount of water. At greater than 15 parts, the effect on fluidity gets saturated, often leading to a drop of the ability to

produce strength.

No particular limitation is imposed on the expanding material used here; generally commercially available products may be used, including calcium sulfoaluminate
5 base expanding material, calcium aluminoferrite base expanding material, and lime base expanding material.

The amount of the expanding material used here is preferably 1 to 5 parts in 100 parts of the binder. At less than 1 part, the effect on reducing shrinkage often
10 gets tenuous, and at greater than 5 parts, not only is there the effect on reducing shrinkage unexpected, but there may also be a drop of compressive strength.

The setting retarder used here is to adjust the setting hardening of rapid hardening mortar, and contains
15 organic acids and alkaline metal carbonates which may be used alone or in combination of two or more.

The organic acid, for instance, includes (anhydrous) citric acid, tartaric acid, oxycarboxylic acids such as gluconic acids or the like or alkaline metal salts thereof.
20 The amount of the organic acid used is preferably 0.1 to 0.3 parts per 100 parts of the binder. At less than 0.1 part, it is often impossible to control the hardening time, and at greater than 0.3 parts, there is often a drop of the ability to produce strength.

25 The carbonate of alkaline metals, for instance, includes carbonates such as lithium carbonate, sodium carbonate and potassium carbonate, bicarbonates such as sodium bicarbonate and potassium bicarbonate. The amount of the carbonate of alkaline metals used is preferably 0.3
30 to 0.8 parts per 100 parts of the binder. At less than 0.3 parts, the effect on promoting the ability to produce strength after hardening is not often expectable, and at

greater than 0.8 parts, there is often a drop of the ability to produce initial strength.

The shrinkage-reducing agent used here is to minimize the shrinkage on drying of grout mortar after
5 hardening, thereby minimizing the occurrence of cracking. The component forming part of the shrinkage-reducing agent is composed mainly of an alkylene oxide adduct of lower alcohols represented by $RO(AO)_nH$ where R is an alkyl group having 4 to 6 carbon atoms, A is one or two or more
10 alkylene groups having 2 to 3 carbon atoms, and n is an integer of 1 to 10, or a polyoxyalkylene derivative or the like represented by the general formula: $X\{O(AO)_nR\}_m$ where X is a residue of a compound having 2 to 8 hydrogen groups, AO is an oxyalkylene group having 2 to 18 carbon atoms, R
15 is a hydrogen atom, a hydrocarbon group having 1 to 18 carbon atoms or an acyl group having 2 to 18 carbon atoms, and m is an integer of 2 to 8, provided that at least 60 mol% of that oxyalkylene group is an oxyethylene group.

The amount of the shrinkage-reducing agent used is
20 preferably 1.3 to 3.8 parts per 100 parts of the binder. At less than 1.3 parts, the effect on reducing shrinkage on drying often gets tenuous, and at greater than 3.8 parts, there is often a drop of the ability to produce strength.

25 The water-reducing agent has functions of dispersing cement and entrapping air, and works in favor of improving fluidity and augmenting strength. Specifically, there is the mention of condensates of melamine sulfonates and condensates of polycarboxylates. To achieve the given
30 fluidity, at least a polycarboxylate base water-reducing agent is used here. Such water-reducing agents are all usable in powdery form, and the polycarboxylate base

water-reducing agent may be used in combination with other water-reducing agents.

The amount of the polycarboxylate base water-reducing agent used is preferably 0.13 to 0.3 parts per 100 parts of the binder. At less than 0.13 parts, there is an occasion where the given fluidity is not obtained, and at greater than 0.3 parts there is an occasion where segregation occurs with a drop of compressive strength. When the melamine sulfonate base water-reducing agent is also used, it is applied in an amount of preferably 0.13 to 0.4 parts, and more preferably about 0.25 parts.

The foaming substance used here is not specifically limited. The foaming substance generates gases after kneaded with water. This action ensures that grout mortar is prevented from sinking, thereby making it integral with structures. For instance, there is the mention of metal powders, and peroxide materials. Particular preference is given to aluminum powders. Note however that it is preferable to use aluminum powders surface treated with vegetable oils, mineral oils, stearic acid or the like, because the surfaces of aluminum powders are susceptible to oxidization, and decrease in reactivity upon covered with an oxidized coating.

The amount of the foaming substance used is preferably 0.0013 to 0.004 parts per 100 parts of the binder. At less than 0.0013 parts, there is an occasion where the amount of expansion is very limited, and at greater than 0.004 parts, there is an occasion where the amount of expansion is very large with a drop of strength.

The viscosity-increasing agent is to adjust the viscosity of mortar, and no particular limitation is imposed on it: generally commercially available ones are

usable. For instance, there is the mention of methyl cellulose, carboxymethyl cellulose, polyvinyl alcohol, polyacrylic acid or its sodium or calcium salt, and polyethylene oxide.

5 The amount of the viscosity-increasing agent used is preferably 0.001 to 0.004 parts per 100 parts of the binder. At less than 0.001, there is an occasion where bleeding cannot fully be prevented, and at greater than 0.004 parts, there is an occasion wherein fluidity drops.

10 The fine aggregate used here is a heavy weight aggregate having a density of at least 3.0 g/cm^3 , for instance, ferrochrome slag. The maximum particle size is preferably up to 5.0 mm.

 The amount of the fine aggregate used is preferably
15 100 to 200 parts per 100 parts of the binder. At less than 100 parts, there is an occasion where the amount of shrinkage grows large, and at greater than 200 parts, there is an occasion where strength or fluidity drops.

 In the invention, defoamers, clay minerals such as
20 bentonite, anion exchangers such as hydrotalcite and so on may be used in addition to the aforesaid ingredients in such a range as to be substantially not detrimental to the object of the invention.

 In the invention, the grouting cement mortar
25 composition having such materials blended together is kneaded with water into grout mortar.

 Not by way of limitation, the amount of water kneaded is preferably 31 to 36 parts per 100 parts of the binder. When there is a deviation from this range, there
30 is an occasion where fluidity drops or segregation occurs, and there is an occasion where the ability to produce strength drops as well.

In the invention, no particular limitation is placed on how to mix the materials: they may be mixed at work sites or a part or the whole of them may be mixed beforehand.

5 For mixing machines, every known machine may be used, for instance, from tilting mixers to omni mixers to Henschel mixers to V-type mixers to Nauta mixers.

By way of example but not by way of limitation, the invention is now explained with reference to examples.

10

Example 1

The rapid-hardening material set out in Table 1 (the amount of cement is obtained by subtracting the amount of the rapid-hardening material from 85 parts), 10 parts of
15 finely pulverized pozzolan, 2.5 parts of an expanding material and 2.5 parts of finely pulverized cement were contained in 100 parts of the binder. One hundred parts of the binder were blended with 0.75 parts of the setting retarder, 2.5 parts of the shrinkage-reducing agent, 0.25
20 parts of the melamine sulfonate base water-reducing agent, 0.2 parts of the polycarboxylate base water-reducing agent, 0.0025 parts of the foaming substance, 0.003 parts of the viscosity-increasing agent and 150 parts of the fine aggregate into a grouting cement mortar composition, which
25 was then kneaded with 34 parts of water using a high-speed hand mixer into grout mortar. This grout mortar was then measured for its fluidity, bleeding ratio, volume expansion ratio and compressive strength. The results are set out in Table 1.

30 Materials Used:

Cement:

Commercial normal Portland cement product having a density

of 3.15 g/cm³

Rapid-Hardening Material:

Calcium aluminosilicate glass/anhydrous calcium sulfate
blended at 1/1 by mass and having a density of 2.94 g/cm³

5 Finely pulverized pozzolan:

Commercially available silica fume product originating
from zirconia

Expanding material:

Material based on calcium sulfoaluminate

10 Finely pulverized cement:

Pulverized and classified normal Portland cement having a
mean particle size of 10 µm

Setting retarder:

25% (Anhydrous) citric acid, 75% potassium carbonate

15 Shrinkage-reducing agent:

Commercial shrinkage reducing agent based on polyalkylene
glycol

Water-reducing agent:

A: Commercial water-reducing agent based on melamine
20 sulfonate

B: Commercial water-reducing agent based polycarboxylate

Foaming agent:

Commercial metallic aluminum powder

Viscosity-increasing agent:

25 Commercial viscosity-increasing agent based on methyl
cellulose

Fine aggregate:

Ferrochrome slag having a density of 3.20 g/cm³, under 4
mm.

30 Measuring Methods

Fluidity:

J₁₄ funnel efflux values were measured according to

the Japan Society of Civil Engineers Standards (JSCE-F541-1999) "Fluidity Testing Method for Filled Mortar".

Bleeding Ratio:

5 Bleeding was measured according to the Japan Society of Civil Engineers Standards (JSCE-F542-1999) "Bleeding Ratio and Expansion Ratio Testing Method for Filled Mortars".

Length Change:

10 According to the Japan Society of Civil Engineers Standards (JSCE-F542-1999) "Expansion Testing Method for Expanding Material by Mortar", grout mortar was poured in a form in a constant-temperature and constant-humidity room of 20°C and 80% RH, and one day after the pouring the grout mortar was measured for length change. Then, the
15 grout mortar was aged in water for seven days, after which it was aged in a constant-temperature and constant-humidity room of 20°C and 80% RH for length change measurement.

Volume Expansion Ratio:

20 According to the Japan Society of Civil Engineers Standards (JISA-6202-1197) "Bleeding Ratio and Expansion Ratio Testing Method for Filled Mortars", grout mortar was poured in a form in a constant-temperature and constant-humidity room of 20°C and 80%RH to take measurements one
25 day after the pouring.

Compressive Strength:

30 According to the Japan Society of Civil Engineers Standards (JSCE-G541-1999) "Compressive Strength Testing Method for Filled Mortars", grout mortar was poured in a form in a constant-temperature and constant-humidity room of 20°C and 80%RH to measure 6-hour strength (Table 1) and compressive strength of 28 days old material that was aged

in water of 20°C after one day went by.

Table 1

Experiment No.	Rapid-Hardening Material (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
1-1	0	9.8	0.0	+0.47
1-2	9	9.2	0.0	+0.45
1-3	12	8.5	0.0	+0.45
1-4	15	7.8	0.0	+0.45
1-5	18	7.4	0.0	+0.48
1-6	21	7.2	0.0	+0.49
1-7	25	7.0	0.0	+0.50

Experiment No.	Compressive Strength of 6-Hour Old Material (N/mm ²)	Remarks
1-1	-	Comparative
1-2	3.5	Inventive
1-3	4.8	Inventive
1-4	7.2	Inventive
1-5	10.2	Inventive
1-6	14.2	Inventive
1-7	16.5	Inventive

5

- Could not be measured

From Table 1 it is found that the inventive grout mortars containing the rapid-hardening agent have good fluidity, are free of bleeding, show low shrinkage and have high compressive strength (Experiment Nos. 1-2 to 1-7), whereas the comparative grout mortar containing none of the rapid-hardening agent decreases in terms of the ability to produce strength (Experiment No. 1-1).

15

Example 2

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening agent and the finely pulverized pozzolan set out in Table 2 were contained in 100 parts of the binder. The results are also set out in Table 2.

Table 2

Experiment No.	Finely Pulverized Pozzolan (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
2-1	0	-	0.05	+0.30
2-2	5	9.8	0.0	+0.32
1-5	10	7.4	0.0	+0.48
2-3	15	6.2	0.0	+0.54

Experiment No.	Compressive Strength of 28-day Old Material (N/mm ²)	Remarks
2-1	65.8	Comparative
2-2	64.4	Inventive
1-5	64.8	Inventive
2-3	64.5	Inventive

10 - Could not be measured

From Table 2, it is found that the inventive grout mortars containing the finely pulverized pozzolan have good fluidity, are free of bleeding, and have low shrinkage and high compressive strength (Experiment Nos. 2-2, 1-5 and 2-3), whereas the comparative grout mortar containing none of the finely pulverized pozzolan decreases in fluidity (Experiment No. 2-1).

Example 3

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the binder, and the setting retarder set out in Table 3 was added to 100 parts of the binder. The results are also set out in Table 3.

Table 3

Experiment No.	Setting Retarder (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Setting Time (min.)
3-1	0.37	7.8	0.0	30
3-2	0.50	7.5	0.0	41
3-3	0.63	7.8	0.0	55
1-5	0.75	7.4	0.0	58
3-4	0.88	7.2	0.0	115

10

Experiment No.	Compressive Strength of 6-Hour Old Material (N/mm ²)	Remarks
3-1	16.2	Inventive
3-2	14.5	Inventive
3-3	14.2	Inventive
1-5	10.2	Inventive
3-4	8.4	Inventive

From Table 3, it is found that the inventive grout mortars with the setting retarder added to them have good fluidity, are free of bleeding, and have a suitable setting time and high compressive strength.

15

Example 4

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-

hardening material were contained in 100 parts of the binder, and the shrinkage-reducing agent set out in Table 4 was added to 100 parts of the binder. The results are also set out in Table 4.

5

Table 4

Experiment No.	Shrinkage-Reducing Agent (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Length Change Ratio ($\times 10^{-6}$)
4-1	0	9.8	0.0	-200
4-2	1.3	9.2	0.0	-50
1-5	2.5	7.4	0.0	+30
4-3	3.8	6.2	0.0	+74

Experiment No.	Volume Expansion Ratio (%)	Compressive Strength of 28-Day Old Material (N/mm^2)	Remarks
4-1	+0.30	70.2	Inventive
4-2	+0.32	69.4	Inventive
1-5	+0.48	64.8	Inventive
4-3	+0.54	60.5	Inventive

The length change ratio was the value of 28-day old material.

10

Example 5

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the binder, and 0.25 part of melamine sulfonate base water-reducing agent and the polycarboxylate base water-reducing agent set out in Table 5 were added to 100 parts of the binder. The results are also set out in Table 5.

15

Table 5

Experiment No.	Water-Reducing Agent (parts)	Fluidity (sec.)	Bleeding Ratio (%)
5-1	0	-	0.0
5-2	0.13	9.4	0.0
5-3	0.15	8.6	0.0
1-5	0.20	7.4	0.0
5-4	0.25	6.9	0.0
5-5	0.30	6.2	0.0

Experiment No.	Compressive Strength of 28-Day Old Material (N/mm ²)	Segregation	Remarks
5-1	66.3	Not Found	Comparative
5-2	64.9	Not Found	Inventive
5-3	65.4	Not Found	Inventive
1-5	64.8	Not Found	Inventive
5-4	63.9	Not Found	Inventive
5-5	65.4	Not Found	Inventive

Polycarboxylate base water-reducing agent (parts);

- : Could not be measured

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From Table 5, it is found that the inventive grout mortars containing the polycarboxylate base water-reducing agent have good fluidity, are free of bleeding, and have high compressive strength (Experiment Nos. 5-2, 5-3, 5-4, 10 5-5, 1-5), whereas the comparative grout mortar containing none of the polycarboxylate base water-reducing agent decreases in fluidity (Experiment No. 5-1).

Example 6

15 Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the

binder, and the foaming substance set out in Table 6 was added to 100 parts of the binder. The results are also set out in Table 6.

5

Table 6

Experiment No.	Foaming Substance (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
6-1	0	7.6	0.0	-0.35
6-2	0.0013	7.5	0.0	+0.11
6-3	0.0019	7.6	0.0	+0.35
1-5	0.0025	7.4	0.0	+0.48
6-4	0.0033	7.7	0.0	+0.56
6-5	0.0040	7.4	0.0	+0.69

Experiment No.	Compressive Strength of 28-Day Old Material (N/mm ²)	Remarks
6-1	65.0	Inventive
6-2	65.1	Inventive
6-3	65.4	Inventive
1-5	64.8	Inventive
6-4	63.8	Inventive
6-5	62.6	Inventive

Example 7

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the binder, and the viscosity-increasing agent set out in Table 7 was added to 100 parts of the binder. The results are also set out in Table 7.

Table 7

Experiment No.	Viscosity-Increasing Agent (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
7-1	0	5.2	0.08	+0.55
7-2	0.001	6.5	0.03	+0.54
1-5	0.003	7.4	0.0	+0.48
7-3	0.004	9.6	0.0	+0.30

Experiment No.	Compressive Strength of 28-Day Old Material (N/mm ²)	Remarks
7-1	65.1	Inventive
7-2	64.9	Inventive
1-5	64.8	Inventive
7-3	62.3	Inventive

Example 8

- 5 Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the binder, and the fine aggregate set out in Table 8 was added to 100 parts of the binder. The results are also
- 10 set out in Table 8.

Table 8

Experiment No.	Fine Aggregate (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
8-1	100	9.7	0.0	+0.53
1-5	150	7.4	0.0	+0.48
8-2	175	8.5	0.0	+0.31
8-3	200	9.5	0.0	+0.35

Experiment No.	Compressive Strength of 28-Day Old Material (N/mm ²)	Remarks
8-1	77.0	Inventive
1-5	64.8	Inventive
8-2	59.8	Inventive
8-3	55.4	Inventive

Example 9

Grout mortars were prepared and measured as in Example 1 with the exception that 18 parts of the rapid-hardening material were contained in 100 parts of the binder, and the water set out in Table 9 was added to 100 parts of the binder. The results are also set out in Table 9.

10

Table 9

Experiment No.	Water (parts)	Fluidity (sec.)	Bleeding Ratio (%)	Volume Expansion Ratio (%)
9-1	30	12.6	0.0	+0.33
9-2	32	8.8	0.0	+0.35
1-5	34	7.4	0.0	+0.48
9-3	36	6.3	0.0	+0.52
9-4	38	5.1	0.0	+0.55

Experiment No.	Compressive Strength of 28-Day Old Material (N/mm ²)	Remarks
9-1	75.5	Inventive
9-2	70.9	Inventive
1-5	64.8	Inventive
9-3	63.7	Inventive
9-4	55.9	Inventive

Example 10

Using the grout mortar blend of Experiment No. 1-5, impact resistance testing with a falling steel ball and abrasion loss testing with a taper abrasion testing machine were conducted. For the purpose of comparison, testing was carried out with a grout mortar wherein in the Experiment No. 1-5 blend, the heavy weight aggregate was replaced by lime sand (having a density of 2.60 g/cm^3), and a grout mortar using an iron powder aggregate and manufactured by a competitor.

Measuring Methods

Impact resistance testing:

Test piece size: $150 \times 150 \times 50 \text{ mm}$

Steel ball size: $\phi 100 \text{ mm} \times 4 \text{ kg}$

Falling height: 1 m

Abrasion resistance testing:

Taper abrasion testing (abrasion loss)

Load: 1 kg

Abrasion wheel H-22

Testing cycle: 1,000 cycles

Table 10

Experi- ment No.	Aggregate	Flui- dity (sec.)	Compressive Strength of 28-Day Old Material (N/mm^2)	Impact Resistance Falling Testing Cycles
1-5	Ferrochrome Slag	7.4	64.8	160
10-1	Lime Sand	8.0	60.7	70
10-2	Iron Powder Aggregate	6.4	62.7	120

Experi- ment No.	Abrasion Loss (g)	Remarks
1-5	2.7	Inventive
10-1	5.8	Comparative
10-2	2.9	Comparative

From Table 10, it is found that the inventive mortar containing the heavy weight aggregate has good fluidity, high compression strength and improved impact resistance and abrasion resistance (Experiment No. 1-5), whereas the comparative grout mortar containing lime sand that is not any heavy weight aggregate has low compressive strength, and is inferior in terms of impact resistance and abrasion resistance (Experiment No. 10-1). In addition, the inventive grout mortar is superior in performance over the commercial product containing the heavy weight aggregate (Experiment No. 10-2).

Utilization of the Invention in the Industry

Cement mortars using the inventive grout cement mortar have good fluidity, high strength, strong robustness and low shrinkage as described above, and so are applicable to the civil engineering and construction field in general, and structures such as machinery foundations in particular.

WHAT IS CLAIMED IS:

1. A grouting cement mortar composition comprising a binder, a setting retarder, a water-reducing agent and a fine aggregate, characterized in that said
5 binder contains a rapid-hardening material comprising cement, calcium aluminosilicate glass and calcium sulfate, and finely pulverized pozzolan; said water-reducing agent contains at least a polycarboxylate base water-reducing
10 agent; and said fine aggregate is a heavy weight aggregate having a density of 3.0 g/cm^3 or greater.

2. The grouting cement mortar composition according to claim 1, characterized in that said finely
15 pulverized pozzolan is silica base fine powders having a silicon dioxide content of 90% or higher and having a hydrogen ion concentration lying in an acidic region.

3. The grouting cement mortar composition
20 according to claim 1 or 2, characterized in that said cement contains classified, finely pulverized cement.

4. The grouting cement mortar composition according to any one of claims 1 to 3, characterized in
25 that said binder further contains an expanding agent.

5. The grouting cement mortar composition according to claim 4, characterized in that said inflating agent is a calcium sulfoaluminate base expanding agent
30 having a Blaine's value of $4,000 \text{ cm}^2/\text{g}$ or greater.

6. The grouting cement mortar composition

according to any one of claims 1 to 5, characterized in that said water-reducing agent further contains a melamine sulfonate base water-reducing agent.

5 7. The grouting cement mortar composition according to any one of claims 1 to 6, characterized by further containing a shrinkage-reducing agent.

 8. The grouting cement mortar composition
10 according to any one of claims 1 to 7, characterized by further containing a foaming substance.

 9. The grouting cement mortar composition according to any one of claims 1 to 8, characterized by
15 further containing a viscosity-increasing agent.

 10. A grout mortar wherein the grouting cement mortar composition according to any one of claims 1 to 9 is kneaded with water.
20

 11. The grout mortar according to claim 10, wherein water is used in an amount of 31 to 36 parts per 100 parts of the binder.