

Slag-based hydraulic binder, dry mortar composition comprising same and system for activating a slag-based binder

5 Field of the invention

[0001] The invention lies within the field of powder compositions which comprise binders based on slag and are intended for the preparation of wet formulations for construction, for example, of mortars, more particularly of adhesive mortars.

[0002] The invention relates more particularly to a slag-based hydraulic binder, in particular for
10 mortars, more particularly for adhesive mortars.

[0003] A further subject of the invention is a dry mortar composition comprising such a binder, and also an activating system for said binder.

[0004] The wet formulation obtained by mixing this dry composition with water is likewise embraced by this invention, as is the mixing itself, and also the hardened product produced from this wet
15 formulation.

Technological background of the invention

[0005] Conventional hydraulic binders, particularly for mortars, consist of Portland cements, which have a CO₂ footprint of approximately 870 kg per tonne.

[0006] Replacing the Portland cement (CEM I) in these hydraulic binders is a current environmental
20 issue.

[0007] To accomplish this, it is known practice to employ the following products as CEM I substitutes: ground granulated blast-furnace slags, pozzolanic materials (natural pozzolans, calcined natural pozzolans, synthetic pozzolans), fly ashes (silica and calcium fly ashes), calcined schists, limestones, silica fumes.

[0008] The ground granulated blast-furnace slags have hydraulic and pozzolanic properties, but
25 require activation by addition of lime, soda or gypsum. The setting and/or hardening of the slag is said to be subject to sodium, calcium and sulfate activation.

[0009] Alkaline activation of this kind inevitably involves the presence of substantial amounts of strong bases, thereby making it dangerous to handle the mortar compositions containing them, and
30 dictating "Xi" labelling.

[0010] In order to overcome this hurdle, the construction material binders according to PCT application WO 2011/055063A1 are binders which are based on ground granulated blast-furnace

slag and in which the concentrations of alkalis are reduced. For instance, this PCT application discloses an adhesive mortar composition as follows:

Adhesive binder for tiling with sand		Amount as a percentage of the total weight of dry composition	Total
CaSO ₄	%	1.5	
Fly ashes	%	5.0	
slag (4000 Blaine)	%	35.0	
slag (7500 Blaine)	%	4.5	
Silica sand	%	49.0	
Portland cement 52.5	%	1.0	
Polymer powder (ethylene-vinyl acetate copolymer)	%	3.4	
Cellulose ether	%	0.4	
Alkali metal sulfate	%	0.10	
Alkali metal carbonate	%	0.10	100.0

- 5 The Portland cement may be replaced or combined with a sulfoaluminate cement. The alkali metal sulfate may be a lithium, sodium or potassium sulfate. The alkali metal carbonate may be a lithium, sodium or potassium carbonate.

- 10 **[0011]** In the same vein, international PCT application WO 2017/198930A1 describes a tiling adhesive formulation in the major constituent and a ground granulated blast-furnace slag with an accelerating system comprising ultra-fine particles of magnesium and calcium carbonate. This tiling adhesive has the following composition in particular:

Component	Percentage by weight
Silica sand	53.5
Slag (4000 Blaine)	35.0
Particles of calcium and magnesium carbonates (BET surface area of 4 m ² /g and D ₅₀ of 2.5 µm)	5.0
Polymer powder (ethylene-vinyl acetate copolymer)	3.4
CaSO ₄	1.5
Portland cement 52.5	1.0
Cellulose ether	0.4
Alkali metal sulfate	0.1
Alkali metal carbonate	0.1

The Portland cement may be replaced or combined with a sulfoaluminate cement, a high-alumina cement, a belitic cement and/or a pozzolanic mixture cement. The alkali metal sulfate may be a lithium, sodium or potassium sulfate. The alkali metal carbonate may be a lithium, sodium or potassium carbonate.

[0012] The properties of the mortars in the eventual applications are of course at the heart of the evaluation of the quality of the binder, of its activating system and of the dry composition of mortar in its entirety.

For adhesive mortars, the reference is the standard NF EN 12 004–1 (April 2017). The tensile adhesion under different conditions, for example after an extended open time of 30 minutes, is a key quality criterion.

[0013] The adhesive mortars according to WO 2011/055063 and WO 2017/198930 have performance properties which can be improved on, particularly as regards the tensile adhesion with an extended open time of at least 30 minutes, and return-to-service times. This performance is decisive in terms of the commercial attractiveness of the tiling adhesive.

[0014] European patent application EP2502891A1 describes an activator for latent pozzolanic and/or hydraulic binders, comprising: A) 5 – 50% of NaOH; B) 10 – 90% of CaSO₄·0.5H₂O (optionally Na₂SO₄); Ca(NO₃)₂·4H₂O; D) optionally a CaCO₃-based filler. This activator is incorporated into a binder at a level of 4% by weight. This binder may comprise 60% of blast-furnace slag and 40% of cement, or 40% of cement, 30% of slag and 30% of silicious filler. This European patent application

does not describe adhesive mortar, screeds or renders having improved performance properties with regard, in particular, to adhesion and to return-to-service times.

Objectives of the invention

[0015] In this context, the invention aims to satisfy at least one of the following objectives:

- 5 - to provide a hydraulic binder, particularly for mortars, more particularly for adhesive mortars, for screeds or for renders, for repair mortars, sealing or grouting mortars, or high-performance mortars, intended for aggressive environments such as sulfate-containing waters, de-icing salts, and based on ground granulated blast-furnace slag, intended for the preparation of a composition which is devoid or virtually devoid of Portland CEM cement (binder having an OPC content, for example of
- 10 not more than 30% by dry weight), which enables setting and hardening with an initial mechanical strength which is improved relative to the known binders based on ground and granulated blast-furnace slag;
- to provide a hydraulic binder, in particular for mortars, more particularly for adhesive mortars, for screeds or for renders, which is based on ground granulated blast-furnace slag, is free or virtually
- 15 free from Portland CEM cement (binder having, for example, an OPC content of not more than 30% by dry weight), which enables setting and hardening with an initial mechanical strength which is improved relative to the known binders based on ground and granulated blast-furnace slag;
- to provide a dry mortar composition, more particularly an adhesive mortar, based on ground granulated blast-furnace slag, which is free or virtually free from Portland CEM cement (binder
- 20 having, for example, an OPC content of not more than 5% by dry weight) and which, when mixed with water, conforms to standard NF EN 12 004–1 (April 2017);
- to provide a dry mortar composition, more particularly an adhesive mortar, based on ground granulated blast-furnace slag, which is free or virtually free from Portland CEM cement (binder having, for example, an OPC content of not more than 5% by dry weight) which, when mixed with
- 25 water, conforms to standard NF EN 12 004–1 (April 2017) and which has a tensile adhesion under different conditions, for example after an extended open time of 30 minutes, which is substantially improved relative to that obtained for the adhesive mortars according to WO 2011/055063 and WO 2017/198930 (for $> 0.8 \text{ N/mm}^2$);
- to provide a dry mortar composition, more particularly an adhesive mortar, a screed or render,
- 30 based on ground granulated blast-furnace slag, which is free or virtually free from Portland CEM cement (binder having, for example, an OPC content of not more than 5% by dry weight) which can be packaged in ready-to-use dry mortar form in bags without Xi labelling in accordance with Regulation (EC) 1907/2006-REACH;
- to provide a dry mortar composition, more particularly an adhesive mortar, based on ground
- 35 granulated blast-furnace slag, which is free or virtually free from Portland CEM cement (binder having, for example, an OPC content of not more than 5% by dry weight) which, when mixed with water, conforms to standard NF EN 12 004–1 (April 2017) and which has an open time of between 20 and 30 min at least and/or a setting time of between 30 minutes and 6 hours, and/or a return-to-

- service time of between 4 and 24 hours, for mixing rates (water*100/binder) of between 20 and 30%;
- to provide a dry mortar composition, more particularly an adhesive mortar, a screed or render, based on ground granulated blast-furnace slag, which is free or virtually free from Portland CEM cement (binder having, for example, an OPC content of not more than 5% by dry weight) which
 - 5 satisfies at least one of the objectives above and which is economical and eco-friendly;
 - to provide an activating system for a hydraulic binder for mortars, more particularly for adhesive mortars, for screeds or for renders, which enables some or all of the objectives set out above to be met;
 - to provide a wet formulation, obtained by mixing the dry mortar composition that is the subject of
 - 10 the objectives above with water, said wet formulation having a rheology suitable for its easy use and having at least one of the aforementioned properties for the hardening or hardened products that are obtained on the basis of this wet formulation;
 - to provide processes for preparing the dry composition and the wet formulation that are easy to implement and are economical;
 - 15 - to provide hardened products (prefabricated or otherwise) for construction, obtained on the basis of the wet formulation set out in the abovementioned objectives (paste – grout – coating – mortar – concrete – adhesive mortar – screeds – renders – concrete block – sandwich panel) which are economical and have good long-term mechanical properties (hardness, flexural/compressive strength, durability, cohesion) and good service performance properties (limited shrinkage in
 - 20 particular).

Brief description of the invention

[0016] The invention meets at least one of the above objectives, and relates, according to a first aspect, to a hydraulic binder, in particular for mortars, more particularly for adhesive mortars, comprising (in % by dry weight):

- 25 A. at least 50 of at least one ground and granulated blast-furnace slag;
- B. more than 5, preferably from 5.5 to 30, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- C. more than 5, preferably from 6 to 30, and, more preferably still, from 8 to 20, of at least one source of sulfate ions;
- 30 D. between 1 and 5 of Ca(OH)_2 and/or of Portland cement;
- E. between 0.01 and 1 of at least one alkali metal carbonate, preferably Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof;
- 35 subject to the following conditions:
 - (i) the amount of C is sufficient to allow the sulfate ions of C to react with B and with A;
 - (ii) the amount of F is sufficient so that its reaction with component D in the presence of water brings

the pH of the resulting wet formulation to a value of not less than 12, preferably than 13, for a water-to-mortar mixing rate of between 10 and 35% by weight.

[0017] This slag-rich binder composition is a notable alternative to the CEM I-based binders in terms of a substantial reduction in the carbon footprint (mass of CO₂ equivalent per tonne). Fine-tuning the concentrations of the components ABCDEF optimizes the hydration and the dissolution under alkaline conditions (pH >12) of the slag A. This promotes sodium and sulfate activation of the setting of the hardening of the wet formulation, obtained by mixing a dry composition comprising the binder according to the invention with water. The hardened or hardening products obtained from this wet formulation therefore benefit from an improved early mechanical strength. They were also all of the requirements, particularly standardized requirements, of the end-use applications for which the dry compositions are intended, particularly for mortar and more particularly for adhesive mortar (EN NF 12004 April 2017), comprising the binder according to the invention.

[0018] In one preferred characteristic of the invention, the ratio of the concentrations of component [C] and of component [B] is defined as follows:

0.1 < [C] / [A]; preferably $0.1 \leq [C] / [A] \leq 1$, and, more preferably still,

$0.1 \leq [C] / [A] \leq 0.3$.

$0.5 < [C] / [B]$; preferably $1 \leq [C] / [B] \leq 3$, and, more preferably still, $1 \leq [C] / [B] \leq 2$.

[0019] According to one embodiment, the hydraulic binder according to the invention comprises:

A. 55 to 90, preferably 60 to 85, of at least one ground and granulated blast-furnace slag;

B. 5.5 to 30, preferably 6 to 20, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;

C. 6 to 30, preferably from 8 to 20, of at least one source of sulfate ions;

D. 1 to 5, preferably 2 to 4, of Ca(OH)₂ and/or of Portland cement;

E. 0.01 to 1, preferably 0.1 to 0.5, of Li₂CO₃;

F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO₃; Na₂CO₃; K₂CO₃; and mixtures thereof, with NaHCO₃ being preferred;

G. 0 to 10, preferably from 0 to 20, of at least one binder different from A, B and D, preferably selected from the group comprising – or better still consisting of –: silica or silica-alumina binders, fly ashes, advantageously silica-alumina fly ashes, silica-calcium-alumina fly ashes, expanded or calcined clay dusts and/or metakaolins.

[0020] According to a second of its aspects, the invention therefore relates to a dry mortar composition comprising the binder according to the invention.

[0021] Advantageously, the invention is directed to a dry adhesive mortar composition comprising (in % by dry weight):

A. 10 to 50, preferably 15 to 40, of at least one ground and granulated blast-furnace slag;

B. 0.5 to 20, preferably 1 to 15, of at least one calcium aluminate cement and/or of at least

- one calcium sulfoaluminate cement;
- C. 1 to 30, preferably from 2 to 20, of at least one source of sulfate ions with $1 \leq [C] / [B] \leq 2$;
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- 5 E. 0.02 to 0.8, preferably 0.05 to 0.3, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 30 to 80, preferably from 40 to 70, of at least one type of aggregates preferably selected
- 10 from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime sands and silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- 15 H. 1 to 10, preferably 1 to 5, of at least one redispersible polymer;
- I. 0.01 to 5, preferably 0.05 to 1, of at least one thickener;
- J. 0.01 to 0.5, preferably 0.05 to 0.3, of at least one retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.
- 20 **[0022]** According to another embodiment, the invention is directed to an adhesive mortar composition comprising (in % by dry weight):
- A. 10 to 50, preferably 15 to 40, of at least one ground and granulated blast-furnace slag;
- B. 0.5 to 20, preferably 1 to 15, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- 25 C. 1 to 20, preferably from 2 to 15, of at least one source of sulfate ions with $0.5 \leq [C] / [B] \leq 3$;
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or
- 30 bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 30 to 80, preferably from 40 to 70, of at least one type of aggregates preferably selected from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime sands and silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands
- 35 obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- H. 1 to 10, preferably 1 to 5, of at least one redispersible polymer;
- I. 0.01 to 5, preferably 0.05 to 1, of at least one thickener;

J. 0.01 to 0.5, preferably 0.05 to 0.3, of at least one retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[0023] This adhesive mortar composition is eco-friendly and highly performing. It meets the requirements of standard EN NF 12004 April 2017 on tiling adhesives. It is a ready-to-use dry mortar composition which can be packaged in bags without X_i labelling for alkaline corrosive risk. Furthermore, the sulfo-alkaline activation of the slag A is made possible with a pH of more than 12 during mixing with water according to a water/mortar mixing rate of between 15 and 30%, for example 25%. This adhesive mortar sets rapidly: the adhesion $> 0.5 \text{ N/mm}^2$ at 6 hours or at 24 hours. It is also noteworthy that the concentration I of redispersible polymer in this adhesive mortar according to the invention remains limited, this being beneficial to the economy of the composition.

[0024] A further subject of the invention is an improved dry adhesive mortar composition with rapid hardening, C2F, which when mixed with water meets the standard NF EN 12004 April 2017, comprising (in % by dry weight):

- 15 A. 10 to 35, preferably 20 to 30, of at least one ground and granulated blast-furnace slag;
- B. 2 to 12, preferably 5 to 9, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- C. 2 to 12, preferably from 5 to 9, of at least one source of sulfate ions with $0.5 \leq [C] / [B] \leq 3$;
- 20 D. 0.05 to 5, preferably 0.5 to 2, of Ca(OH)_2 and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- 25 G. 50 to 70, preferably from 52 to 60, of at least one type of aggregates, preferably selected from sands and mixtures thereof;
- H. 1 to 5, preferably 1 to 4, of at least one redispersible polymer powder;
- I. 0.05 to 2, preferably 0.1 to 0.5, of at least one thickener;
- J. 0.05 to 1, preferably 0.1 to 0.5, of at least retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.
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[0025] A further subject of the invention is an improved dry adhesive mortar composition which is deformable, C2S1, which when mixed with water conforms to the standard NF EN 12004 April 2017, comprising (in % by dry weight):

- 35 A. 10 to 30, preferably 20 to 25, of at least one ground and granulated blast-furnace slag;
- B. 1 to 7, preferably 1 to 5, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- C. 1 to 10, preferably from 2 to 9, of at least one source of sulfate ions with

$$0.5 \leq [C] / [B] \leq 3;$$

- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- F. and a percentage of more than 1 and not more than 4, preferably than 3, of at least one
- 5 alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 60 to 90, preferably from 62 to 70, of at least one type of aggregates preferably selected from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime
- 10 sands and silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- H. 1 to 5, preferably 1 to 4, of at least one redispersible polymer powder;
- 15 I. 0.05 to 2, preferably 0.1 to 0.5, of at least one thickener;
- J. 0.05 to 1, preferably 0.1 to 0.5, of at least one retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[0026] A further subject of the invention is an improved dry adhesive mortar composition which is

20 highly deformable, C2S2, which when mixed with water conforms to the standard NF EN 12004 April 2017, comprising (in % by dry weight):

- A. 15 to 40, preferably 25 to 35, of at least one ground and granulated blast-furnace slag;
- B. 1 to 7, preferably 1 to 5, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- 25 C. 1 to 10, preferably from 2 to 9, of at least one source of sulfate ions with
- $0.5 \leq [C] / [B] \leq 3;$
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or
- 30 bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 50 to 70, preferably from 52 to 62, of at least one type of aggregates, preferably selected from sands and mixtures thereof;
- H. 1 to 10, preferably 2 to 8, of at least one redispersible polymer powder;
- 35 I. 0.05 to 2, preferably 0.1 to 0.5, of at least one thickener;
- J. 0.05 to 1, preferably 0.08 to 0.15, of at least retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[0027] The dry mortar composition according to the invention may also be a screed composition or a render composition. This composition may comprise (in % by dry weight):

- A. 3 to 50, preferably 4 to 30, of at least one ground and granulated blast-furnace slag;
- B. 0.5 to 20, preferably 1 to 15, of at least one calcium aluminate cement and/or of at least
5 one calcium sulfoaluminate cement;
- C. 1 to 20, preferably from 2 to 15, of at least one source of sulfate ions with
 $0.5 \leq [C] / [B] \leq 3$;
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- 10 F. and at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 30 to 80, preferably from 40 to 70, of at least one type of aggregates preferably selected from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime
15 sands and silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- H. 1 to 10, preferably 1 to 5, of at least one redispersible polymer;
- 20 I. 0.01 to 5, preferably 0.05 to 1, of at least one thickener;
- J. 0.01 to 0.5, preferably 0.05 to 0.3, of at least one retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[0028] The invention further relates to an improvement to dry mortars, more particularly to adhesive
25 mortars, screeds and renders, said improvement comprising the use of the binder and/or the activating system according to the invention in a dry mortar composition or a wet mortar formulation, more particularly an adhesive mortar, render or screed composition or formulation. The dry mortar composition according to the invention may advantageously include one or more additives selected from the group comprising – ideally consisting of –: water retainers, fillers, light fillers, water repellents,
30 dyes/pigments, fibres, antifoams, plasticizers, air entrainers or foam-formers, in situ gas generators, flame retardants, biocides, dispersants, and mixtures thereof.

[0029] According to another of its aspects, the invention relates to an activating system for a hydraulic binder for mortars, more particularly for adhesive mortars, comprising (in % by dry weight):
35 C. 60 to 93, preferably 70 to 90, of at least one source of sulfate ions;

- D. 5 to 25, preferably 8 to 20, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 1 to 3 of Li_2CO_3 ;
- F. 1 to 15, preferably 2 to 10, of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ;

K_2CO_3 and mixtures thereof.

This binder further comprises (in % by dry weight):

- A. 50 to 99, preferably 60 to 95, of at least one ground and granulated blast-furnace slag;
- B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium
- 5 aluminat cement and/or at least one calcium sulfoaluminat cement.

[0030] According to another embodiment, the invention relates to an activating system for a hydraulic binder for mortars, more particularly for adhesive mortars, renders or screeds, characterized in that it comprises (in % by dry weight):

- C. 60 to 93, preferably 70 to 90, of at least one source of sulfate ions;
- 10 D. 5 to 25, preferably 8 to 20, of $Ca(OH)_2$ and/or of Portland cement;
- E. 0.5 to 5, preferably 1 to 3, of Li_2CO_3 ;
- F. at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: $NaHCO_3$; Na_2CO_3 ; K_2CO_3 and mixtures thereof; and in that the binder comprises (in % by dry weight):
- 15 A. 60 to 99, preferably 70 to 95, of at least one ground and granulated blast-furnace slag;
- B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium aluminat cement and/or at least one calcium sulfoaluminat cement.

[0031] According to another of its aspects, the invention relates to a process for preparing the binder or the dry composition according to the invention. This process essentially comprises mixing the

20 components of said composition, these components being taken separately and/or in the form of one or more partial or complete mixtures.

[0032] The invention, in another of its aspects, is directed to a wet mortar formulation comprising a dry composition according to the invention that is mixed with water, according to a water/mortar mixing rate of between 10 and 35%, preferably between 15 and 30%.

25 More particularly, the wet formulation according to the invention possesses good application performance qualities such as “workability” or rheological properties suitable for pumping. Moreover, this render exhibits, in particular, good mechanical performance properties.

[0033] The invention also relates to a process for preparing a wet mortar formulation, which comprises mixing the components of the dry composition according to the invention with mixing

30 water, advantageously according to a water/mortar mixing rate of between 10 and 35%, preferably between 15 and 30%, said components being taken separately and/or in the form of one or more partial or complete mixtures.

[0034] Lastly, the invention is also directed to the use of an activating system comprising (in % by dry weight):

- 35 C. 60 to 93, preferably 70 to 90, of at least one source of sulfate ions;
- D. 5 to 25, preferably 8 to 20, of $Ca(OH)_2$ and/or of Portland cement;
- E. 0.5 to 5, preferably 1 to 3, of Li_2CO_3 ;

F. 1 to 15, preferably 2 to 10, of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 and mixtures thereof of a hydraulic binder;

for activating a hydraulic binder for mortars, in particular for adhesive mortars, said binder comprising

5 (in % by dry weight):

A. 50 to 99, preferably 60 to 95, of at least one ground and granulated blast-furnace slag;

B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or at least one calcium sulfoaluminate cement;

wherein C is employed in an amount sufficient to allow the sulfate ions of C to react with B and with

10 A.

[0035] According to another embodiment, the invention relates to the use of an activating system comprising (in % by dry weight):

C. 60 to 95, preferably 70 to 90, of at least one source of sulfate ions;

D. 5 to 25, preferably 8 to 20, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;

15 E. 0.5 to 5, preferably 1 to 3, of Li_2CO_3 ;

F. and at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 and mixtures thereof of a hydraulic binder;

for activating a hydraulic binder for mortars, in particular for adhesive mortars, said binder comprising

20 (in % by dry weight):

A. 60 to 99, preferably 70 to 95, of at least one ground and granulated blast-furnace slag;

B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or at least one calcium sulfoaluminate cement;

wherein C is employed in an amount sufficient to allow the sulfate ions of C to react with B and with

25 A.

[0036] Definitions

Throughout the present specification, any singular denotes a singular or a plural interchangeably.

The definitions given below as examples may be used to interpret the present specification:

- "polymer" denotes "homopolymer" and "copolymer" interchangeably;
- 30 • "mortar" denotes a dry or wet or hardened mixture of one or more organic and/or inorganic binders, of aggregates with a diameter < 5 mm (sands – aggregates) and optionally of fillers and/or additives and/or adjuvants;
- "dry" qualifies a mortar or a concrete in pulverulent form, before mixing with an appropriate liquid, preferably water; a dry mortar or a dry concrete is also a ready-to-use
- 35 mortar or concrete, this being one which is ready to be mixed with a mixing liquid in order to form a wet formulation which is intended for use, before hardening, in construction material applications;

- "render" denotes more specifically a mortar which is used as a surface coating on a surface in order to provide it with protection, homogenization, decoration, etc.;
- "screed" denotes more specifically a mortar which is used as a homogeneous sealing system of a certain thickness (standard NF EN 13 300 18 – August 2000);
- 5 • "adhesive mortar" or "adhesive" denotes a dry, wet or hardened composition which is used to adhere tiling to a substrate;
- "paste" denotes a wet composition containing water;
- "filler" is a filler having a bulk density of more than 0.75;
- "light filler" is a filler having a bulk density of not more than 0.75;
- 10 • "liquid": dispersion, emulsion or solution on an aqueous basis.

Detailed description of the invention

[0037] *BINDER ABCDEF*

The inventors have succeeded in developing an eco-friendly binder ABCDEF which is based on ground and granulated blast-furnace slag and which enables the formulation of dry compositions, particularly mortar compositions and more particularly adhesive mortar compositions, which lead, after hardening (mixing with water), to hardened products which are adherent or mechanically strong and which meet the specifications expected in the end-use applications of building products, more particularly of adhesive mortars according to standard EN NF 12004 April 2017.

20 **[0038] The ground and granulated blast-furnace slag A**

This is preferably a ground and dried, granulated blast-furnace slag having an average glass content of more than 90% (measurement by X-ray diffraction). This slag conforms to European standard NF EN 15167-1 of 1 September 2006.

This slag is advantageously a C.E. ground granulated blast-furnace slag produced at Fos-sur-Mer by ECOCEM® and having the following characteristics:

[0039]

CHEMICAL COMPOSITION (average percentage)

SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	TiO ₂	SO ₃	Cl ⁻	S ²⁻	Na ₂ O	K ₂ O	Na ₂ O _{equiv.}
37.3	10.7	0.2	43.0	6.5	0.7	0.1	0.01	0.8	0.23	0.35	0.45

Chemical modulus (CaO+MgO)/SiO₂ : > 1.25 (≥ 1.2 : class A to NF EN 206-1/CN)

CHEMICAL CHARACTERISTICS (representative, indicative values)

Formulation		Compressive strengths			ACTIVITY INDEX			Initial setting time (min)
Ecocem	Reference cement	7d	28d	90d	7d	28d	90d	
0%	100%	43	55	64	--			170
50%	50%	31	55	66	72%	100%	103%	210
Limits of the product standard NF EN 15167-1					≥ 45%	≥ 70%		< 2 x cement setting time
Class A limits acc. to standard NF EN 206/CN					≥ 65%	≥ 85%		

OTHER CHARACTERISTICS

Blaine specific surface area	4 450 ± 250 cm ² /g ≥ 2 750 cm ² /g : NF EN 15167-1 ≥ 4 200 cm ² /g : class A acc. to NF EN 206/CN
Indicative median diameter (d ₅₀)	11 μm
Undersize at 32 μm	≥ 95%
Density	2.90 ± 0.03 g/cm ³
Bulk density	0.8 ± 0.1 g/cm ³
Index [CIE L*a*b*] with CR410	L* = 89.5 ± 2
Loss on ignition (950 °C)	< 1.5%
Moisture content (100 °C)	< 0.5%

Any other ground and granulated blast-furnace slag having the features above with a range of variation of +/- 10% is an appropriate slag A for forming part of the composition of the binder according to the invention.

5

According to one notable mode of the invention, at least a portion of the slag A has a Blaine specific surface area of between 3000 and 5000 cm²/g, preferably between 4200 and 4700 cm²/g, and, optionally, at least one other portion of slag A has a Blaine specific surface area of more than 5000 and not more than 20 000 cm²/g, preferably between 6500 and 8500 cm²/g.

10

[0040] Calcium aluminate and/or sulfoaluminate cement B and/or binder

[0041] Cements based on calcium aluminate (CAC) or high-alumina cements result from the fusing of a mixture of limestone and bauxite, followed by milling without gypsum to a fineness comparable with that of Portland cements. The minimum strengths guaranteed in "standard mortar" are as follows: compressive strength in N/mm² at 6 hours : ≥ 18; at 24 hours: ≥ 40. These cements are defined by standard EN14647.

15

[0042] The cement based on calcium sulfoaluminate (CSA) may be an alitic sulfoaluminate cement, a ye'elimitic cement and/or belitic cement and/or a binder having a high cement-phase content and being rich in alumina: (for example Al₂O₃ > 30%)

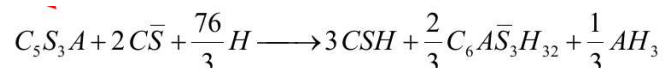
[0043] Sulfate ion source C

- The source C of sulfate ions is selected from the group comprising – or better still consisting of –: natural or synthetic gypsum, calcium sulfate hemihydrate, bassanite, anhydrite, selenite, alabaster, fibrous gypsum, saccharoidal gypsum, marine gypsum, gypsum flower, phosphogypsum (gypsum from phosphoric acid manufacture), desulfurization gypsum, titanogypsum (gypsum from the neutralization of the sulfuric acid produced in the process synthesizing titanium dioxide), citrogypsum (gypsum from citric acid manufacture), tartarogypsum (gypsum from tartaric acid manufacture), borogypsum (gypsum from boric acid manufacture), lactogypsum (gypsum from lactic acid manufacture), and mixtures thereof.
- 5 The amount of C is sufficient to allow the sulfate ions of C to react with B and with A; in other words, there remains sufficient sulfate C to activate the slag A when all of the high-alumina cement or sulfoaluminate cement B has been consumed. Accordingly, the mass ratios C/A and C/B are, for example, as follows:

$$0.1 \leq [C] / [A] \leq 1$$

$$15 \quad 0.5 \leq [C] / [B] \leq 3$$

The following reactions takes place, for example when B is a calcium aluminate cement:

**[0044] Component D: $Ca(OH)_2$ and/or Portland cement CEM**

Lime $Ca(OH)_2$: This may be provided by quicklime, slaked lime, air lime, or hydraulic lime.

- 20 $Ca(OH)_2$ is preferably selected from the group comprising – ideally consisting of – the following limes: CL 90, DL 85, CL 80, DL 80, CL 70, DL 70, HL 2, HL 3.5, HL 5, NHL 2, NHL 3.5, NHL 5, NHL – Z, and mixtures thereof

It may for example be Chaubat CL90 air lime from Bonargent-Goyon; white hydraulic lime NHL-3.5Z CE sold by Lafarge ciments, usine du Cruas (composition: lime 89%, CEM II/A-LL 42.5 N CE PM-

- 25 CP2 NF "white": 11%).

Portland cement:

- In accordance with the invention, the Portland cement conforms to that defined in the European standard EN 197-1, comprising five classes as follows: CEM I: Portland cement; CEM II: composite Portland cement; CEM III: blast-furnace cement; CEM IV: pozzolanic cement; CEM V: composite cement.

Mention may be made, by way of example, of the following: CEM I 42.5 R, Portland cement CEM I, 52.5N.

[0045] Alkali metal carbonate E

- According to one noteworthy mode of the invention, component E may be lithium carbonate, potassium carbonate and/or sodium carbonate. Lithium carbonate is preferred.

[0046] Alkalifying reagent F

F is a metal carbonate and/or bicarbonate, preferably $NaHCO_3$; Na_2CO_3 ; K_2CO_3 ; with $KHCO_3$ being

preferred.

The amounts of [D] and [F] are sufficient to react in a formulation comprising the binder, aggregates, fillers, water and, optionally, additives, and to bring the pH of this wet formulation to a value of not less than 12, preferably not less than 13. This may correspond, for example, to the following ratios [F]

5 / [D]:

$0.2 < [F] / [D]$; preferably $0.2 \leq [F] / [D] \leq 1.5$, and, more preferably still,

$0.3 \leq [F] / [D] \leq 1$.

The reaction is, for example, $\text{Ca(OH)}_2 + \text{NaHCO}_3 \rightarrow \text{NaOH} + \text{CaCO}_3$.

[0047] Binder G different from A, B and D

10 G is preferably selected from the group comprising – or better still consisting of –: silica or silica-alumina binders, fly ashes, advantageously silica-alumina fly ashes, silica-calcium-alumina fly ashes, expanded or calcined clay dusts and/or metakaolins.

Possible examples include the metakaolins obtained by a flash process or a traditional process, and fly ashes of type C or F.

15 **[0048] DRY MORTAR COMPOSITION ABCDEF(G)HIJK**

This composition is, for example, an adhesive mortar, a screed or a render. Components ABCDEF and their respective proportions are defined above. The aggregates or fillers H, the redispersible polymers I, the thickness J and the retarders K are defined below.

[0049] Aggregates or fillers H

20 They are advantageously selected from the group comprising or, better still, consisting of: fillers and/or sands, preferably from silica, lime, silica-lime and magnesium-containing sands and mixtures thereof, silica, lime and silica-lime and magnesium-containing fillers and mixtures thereof, and/or from metal oxides, aluminas, and/or from glass beads and natural and synthetic silicate minerals preferably selected from clays, micas, metakaolins, silica fumes and mixtures thereof.

25 **[0050] Redispersible polymers I**

I is selected from the group comprising or, better still, consisting of the following classes of resins: acrylic homo- or copolymers, ethylene-vinyl acetate copolymers, styrene-acrylic copolymers, terpolymers of vinyl acetate, vinyl versatate and dialkyl maleate, copolymers of vinyl acetate and vinyl versatate, copolymers of styrene and butadiene, and mixtures thereof.

30 **[0051] Thickeners J**

J is selected from the group comprising or, better still, consisting of polysaccharides and preferably cellulose ethers or starch ethers and mixtures thereof, and preferably from the group comprising methyl celluloses, hydroxyethyl celluloses, methylhydroxypropyl celluloses, methylhydroxyethyl celluloses and mixtures thereof, or from modified or unmodified guar ethers and mixtures thereof, or

35 a mixture of these different classes.

[0052] Retarders K

K is selected from the group comprising or, better still, consisting of calcium-chelating agents, carboxylic acids and salts thereof, polysaccharides and derivatives thereof, phosphonates, lignosulfonates, phosphates, borates, and lead, zinc, copper, arsenic and antimony salts, and more

particularly from tartaric acid and its salts, preferably its sodium or potassium salts, citric acid and its salts, preferably its sodium salt (trisodium citrate), sodium gluconates; sodium phosphonates; sulfates and their sodium or potassium salts, and mixtures thereof.

[0053] Various other additives may also be employed in the dry mortar composition, more particularly
5 adhesive mortar composition.

These additives may be setting accelerators, water retainers, light fillers, water repellents, colourants, fibres, antifoams, rheological agents, air entrainers or foam-formers, gas-generating agents, flame retardants, etc., and mixtures thereof.

The setting accelerator additive may be selected from the group comprising or, better still, consisting
10 of the alkali metal and alkaline earth metal salts of hydroxides, halides, nitrates, nitrites, carbonates, thiocyanates, sulfates, thiosulfates, perchlorates, silica, aluminium, and/or from carboxylic and hydroxycarboxylic acids and salts thereof, alkanolamines, insoluble silicate compounds such as silica fumes, fly ashes or natural pozzolans, quaternary ammonium silicates, finely divided inorganic compounds such as finely divided magnesium and/or calcium carbonates or silica gels, and mixtures
15 thereof; said complementary setting accelerator (e) being preferably selected from the group comprising or, better still, consisting of chlorides and their sodium or calcium salts, carbonates and their sodium or lithium salts, sulfates and their sodium or potassium salts, calcium formates and hydroxides, and mixtures thereof.

The colourant additive is advantageously selected from the group comprising or, better still,
20 consisting of organic and/or inorganic pigments, and more particularly from the oxides of iron, titanium, chromium, tin, nickel, cobalt, zinc and/or antimony, and/or from polysulfided sodium aluminosilicates, carbon, sulfides of cobalt, manganese, zinc, and/or from pigments which have high transparency or high reflectivity for infra-red radiation, and mixtures thereof.

The light filler additive is advantageously selected from the group comprising, or better still, consisting
25 of: expanded perlite, expanded vermiculite, silica aerogels, expanded polystyrene, cenospheres (fillites®), hollow alumina beads, expanded clays, pumices, hollow glass beads (3M® type) or expanded glass granules (Poraver®, Liaver®), silicate foam particles, and rhyolite (Noblite®).

The water repellent additive is advantageously selected from the group comprising or, better still, consisting of agents in the form of fluorine, silane, silicone and siloxane compounds, metal salts of
30 fatty acids and mixtures thereof, and preferably from the sodium, potassium and/or magnesium salts of oleic and/or stearic acid and mixtures thereof.

The fibre additive preferably comprises mineral, animal, plant and synthetic fibres, more particularly selected from the group comprising or, better still, consisting of fibres of polyamide, polyacrylonitrile, polyacrylate, cellulose, polypropylene, polyvinyl alcohol, glass, metal, flax, polycarbonate, sisal, jute
35 and hemp, and mixtures of these fibres.

The antifoam additive is preferably selected from the group comprising or, better still, consisting of polyether polyols, hydrocarbon molecules, silicone molecules, hydrophobic esters, nonionic surfactants, polyoxiranes, and mixtures thereof.

The rheological additive is preferably selected from the group comprising or, better still, consisting of

thickeners, plasticizers (organic and/or inorganic) and mixtures thereof, and preferably from the subgroup comprising or, better still, consisting of polysaccharides and derivatives thereof, polyvinyl alcohols, inorganic thickeners, linear polyacrylamides, polynaphthalene sulfonates, polymelamine sulfonates, polycarboxylate ethers, polycarboxylate esters and mixtures thereof.

- 5 The surfactant additive is anionic, nonionic or amphoteric.

The sources of anionic surfactants are, for example, alkyl sulfates, alkyl ether sulfates, alkarylsulfonates, alkylsuccinates, alkylsulfosuccinates, alkoyl sarcosinates, alkyl phosphates, alkyl ether phosphates, alkyl ether carboxylates, and/or alpha-olefinsulfonates, and preferably sodium lauryl sulfate.

- 10 The nonionic surfactants are, for example, ethoxylated fatty alcohols, mono- or dialkyl alkanolamides, and/or alkyl polyglucosides.

The amphoteric surfactants are, for example, alkyl amine oxides, alkyl betaïnes, alkyl amido propyl betaïnes, alkyl sulfobetaines, alkyl glycinate, alkyl amphopropionates, and/or alkyl amidopropyl hydroxysultaines.

- 15 The in situ gas generator additive is advantageously selected from those adjuvants which, in contact with the compositions according to the invention, generate oxygen, hydrogen, nitrogen, carbon monoxide or dioxide, ammonia or methane. They may be selected from the adjuvants described in US 7,288,147, and more particularly from the classes of the azodicarbonamides, sodium bicarbonate, organic or inorganic peroxides, toluene sulfonyl hydrazide, benzene sulfonyl hydrazide, toluene
20 sulfonyl acetone hydrazone, toluene sulfonyl semicarbazide, phenyltetrazole, sodium borohydride and dinitrosopentamethylenetetramine.

The flame retardant additive is advantageously selected from the group comprising or, better still, consisting of flame-retarding agents having chemical and/or physical activities, halogenated flame retardants, phosphorus-containing flame retardants, nitrogen-containing flame retardants,
25 intumescent systems, inorganic flame retardants, metal hydroxides, zinc compounds, borates, antimony oxides, nanocomposites based on clays based on aluminium silicates, and mixtures thereof; and preferably from the subgroup comprising or, better still, consisting of Tetrachlorobisphenol A (TBBPA), chlorinated paraffins, organic phosphates, red phosphorus, phosphonates, phosphinates, melamine, its salts and homologues, aluminium hydroxides or
30 magnesium hydroxides, zinc hydroxystannates, zinc borate, and mixtures thereof.

[0054] ACTIVATING SYSTEM

The invention likewise relates to an activated system CDEF for a binder AB.

[0055] WET FORMULATION

- The invention likewise relates to a wet formulation obtained from the dry composition defined above
35 mixed with water, preferably according to a mixing rate of between 10 and 35%, preferably between 15 and 30%.

[0056] PROCESS FOR PREPARING A WET FORMULATION

The invention likewise relates to a process for preparing the wet formulation above.

[0057] USE OF AN ACTIVATING SYSTEM

The invention likewise relates to the use of an activating system CDEF for a binder AB.

[0058] HARDENED PRODUCTS FOR CONSTRUCTION

The invention is also directed to the hardened products for construction that are obtained starting
 5 from the above wet formulation and/or from that obtained by the process defined below, these
 hardened products being, in particular, as follows: products obtained on the building site by
 hardening the wet formulations resulting from the mixing of the compositions according to the
 invention, e.g.: adhesive mortars, seals, patching renders, smoothing renders; screeds, lightweight
 10 screeds for heated floors; exterior coatings in the form of thick-film or thin-film mineral coatings and
 mineral paints; components of exterior thermal insulation (ETI) systems, including the adhesive for
 insulating material, the undercoat used to fix the mesh, and the exterior finishing coat; tiling
 adhesives; tiling seals; jointing renders; interior and exterior renders, for example single-coat
 renders; insulating material for the exterior or interior of buildings; filling mortars or concretes;
 15 grouting mortar, mortars for concrete repair, mortars with freeze-thaw resistance, a concrete
 waterproofing system, sealing membranes; injection slurries, lightweight slurries for the cementation
 of oil wells; lightweight mortars or concretes intended for placement by spraying or pouring into hollow
 walls or into permanent formwork for the production of new buildings or the renovation of old
 buildings; products prefabricated industrially by hardening the wet formulations resulting from the
 mixing of the compositions according to the invention, e.g.: lightweight prefabricated panels intended
 20 for the assembly of buildings (load-bearing elements or insulating panels); lightweight concrete
 blocks for the use as structural or insulating or facing elements; prefabricated elements, such as
 window sills, brackets, mouldings, etc.

[0059] Construction or civil engineering works

The invention also relates to construction or civil engineering works carried out at least partly with a
 25 wet formulation, this formulation hardening after it has been applied and shaped, or on the basis of
 the hardened construction products.

[0060] PROCESSES

The invention also relates to processes for preparing the dry composition above, the process for
 applying the wet formulation defined above to a building surface, or the process for producing
 30 hardened products for construction, for building or civil engineering works, by means of the wet
 formulation according to the invention.

[0061] EXAMPLES

Examples 1 to 3

Table 1 below gives the formulas of three adhesive mortar compositions - C2S, C2S2 and C2F –
 35 according to examples 1, 2 and 3

[0062] I. MATERIALS USED

Binder A, ground and granulated blast-furnace slag: Ecocem® ground slag

Component B: TERNAL® RG calcium aluminate cement from Imerys® Aluminates

- $\text{CaO} \cdot \text{Al}_2\text{O}_3 - 2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2 - 12\text{CaO} \cdot 7\text{Al}_2\text{O}_3 - 2\text{CaO} \cdot \text{SiO}_2 - 4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$

Component C: source of sulfate ions: "SULFACAL AH Micro AF" CaSO_4 , micronized anhydrite from SMA FAULQUEMONT 57

Component D: Tradical® H90 from LHOIST (Précy sur Oise/ U59)

5 Component H:

1) natural calcium carbonate BL200 sold by Omya

2) Dried washed sand PE2LS – Fulchiron

Component I: redispersible polymer based on a vinyl acetate/vinyl chloride/ethylene copolymer, having a minimum film-forming temperature of 5°C.

10 Component J: hydroxyethylmethylcellulose (HEMC) with MW 40 000 or Opagel CMT pregelatinized starch ether 500-1500 mPa.s from AVEBE®

Component E: lithium carbonate from RODACHEM BV

Component F: alkalifying reagent NaHCO_3 from BRENNTAG SA

Retarder K: tartaric acid from Ets FAURE et FILS, trisodium citrate from BRENNTAG SA, sodium

15 gluconates from UNIVAR, citric acid from UNIVAR.

[0063] II. TESTS:

The standard employed for the test of determining the flexural and compressive strengths is NF EN 196-1.

III. PREPARATION OF MORTARS:

20 Procedure

Preparation of dry mixes:

The powdered starting materials are weighed out independently in accordance with the formulations.

The starting materials are then mixed in a Guedu powder mixer for 3 minutes.

Water mixing of the dry mixes

25 The dry mortars obtained are mixed with the water required to produce a homogeneous paste, in a Perrier planetary mixer, for one minute and thirty seconds.

[0064] TABLE 1

		C_2S_1	C_2S_2	C_2F
		Example 1	Example 2	Example 3
SM	Type	%	%	%
ECOCEM FOS slag	Binder A (ground and granulated blast-furnace slag)	22.5	29.5	27
Ternal RG (Imerys Aluminates)	B: calcium aluminate cement	2.5	2.5	7
Micronized anhydrite	C: Source of sulfate ions, CaSO_4	4	4	7

Tradical H90 (Précy sur Oise / U59)	D: Ca(OH)_2 CL90	0.9	0.9	0.9
BL200EN	H: CaCO_3 aggregate/filler	2.5	0	0
PE2LS	H: silica sand aggregate/filler 0.1 – 0.4 mm	64.1	57.22	55.01
Redispersible polymer	I: copolymer of vinyl acetate, vinyl chloride and ethylene, having a minimum film-forming temperature of 5°C	2.5	5	2
Thickener J1	J1: Hydroxyethylmethyl cellulose HEMC 35 000-45 000 mPas	0.25	0.25	0.25
Thickener J2	J2: pregelatinized starch ether 500-1500 mPas	0.1	0	0
Lithium carbonate	E: Li_2CO_3	0.1	0.1	0.1
Sodium bicarbonate	F: alkalifying reagent, NaHCO_3	0.4	0.4	0.4
	K: mixture of retarders	0.15	0.13	0.34
	CO_2 footprint (kg/t)	182	256	189

[0065] IV. RESULTS**[0066]** Table 2

	Example 1	Example 2	Example 3
Water demand (%)	22	23.5	24.5
Viscosity (Pa s)	330	290	310
Adhesion (MPa) 6 hours	-	-	0.55
Adhesion (MPa) 24 hours at 20°C	0.48	0.51	0.75
Adhesion (MPa) 24 hours at 5°C	0.30	-	0.48
Adhesion (MPa) 28 days	1.41	1.45	1.66
Wet adhesion (MPa) 28 days	1.60	1.91	1.28
Adhesion (MPa) with respect to heat, 28 days	1.46	1.63	1.71
Adhesion (MPa) open time 30 minutes	0.89	1.11	1.19
Deformability mm/m	2.64	5.12	NC
% transfer 10 mm	100	100	100
% transfer 15 mm	100	100	90
% transfer 20 mm	80	95	90
% transfer 25 mm	70	90	90
% transfer 30 mm	40	45	80

[0067] V. Comments:

- 5 The binder, the activating system and the mortars, more particularly the adhesive mortars, according to the invention (based on ground granulated blast-furnace slag with a low carbon footprint) are economical, exhibit a good open time and good transfer, have a satisfactory setting time at 5 and 20°C, possess high deformability with low levels of redispersible polymer, and do not require corrosive “X” labelling on the bags of dry mortar.
- 10 The wet formulations according to the invention also have good handling qualities, making them easier to use.

[0068] EXAMPLES 4 TO 8

[0069] Tables 3 and 4 below give the formulas and the performance properties of three C2S1 adhesive mortar compositions and of two C2F adhesive mortar compositions. The materials employed, the preparation of the mortars and the tests are the same as for examples 1 to 3.

5 **[0070]** Table 3

		C2S1 ADHESIVE		
Components of the compositions according to the invention	Components	Example 4	Example 5	Example 6
		Percentage in the mortar formula		
		(%)	(%)	(%)
A	GGBS	29.5	29.5	22.5
B	CAC	2.5	2.5	2.5
C	C\$	4	4	4
D	Ca(OH) ₂	0.9	0.9	0.9
E	Li ₂ CO ₃	0	0.1	0.1
F	NaHCO ₃	0.4	0.4	0.4
		Percentage expressed at 100% relative to the binder		
		(%)	(%)	(%)
A	GGBS	79	79	74
B	CAC	7	7	8
C	C\$	11	11	13
D	Ca(OH) ₂	2.41	2.41	2.96
E	Li ₂ CO ₃	0	0.27	0.33
F	NaHCO ₃	1.07	1.07	1.32
Performance property	Adhesion in water (MPa)	0.53	1.91	1.17
	Ratio C/A	0.14	0.14	0.18
	Ratio C/B	1.60	1.60	1.60
	Ratio F/D	0.44	0.44	0.44

[0071] Table 4

		C2S1 ADHESIVE	
Components of the compositions according to the invention:	Components:	Example 7	Example 8
		Percentage in the formula of mortar	
		(%)	(%)
A	GGBS	27	27
B	CAC	7	7
C	C\$	5.6	7
D	Ca(OH) ₂	0.9	0.9
E	Li ₂ CO ₃	0.1	0.1
F	NaHCO ₃	0.4	0.4
		Percentages expressed at 100% relative to the binder	
		(%)	(%)
A	GGBS	66	64
B	CAC	17	17
C	C\$	14	17
D	Ca(OH) ₂	2.2	2.12
E	Li ₂ CO ₃	0.24	0.24
F	NaHCO ₃	0.98	0.94
Performance property	Adhesion in water (MPa)	0.77	1.22
	Ratio C/A	0.21	0.26
	Ratio C/B	0.80	1.00
	Ratio F/D	0.44	0.44

[0072] EXAMPLES 9 AND 10

5 Table 5 below gives the formulas and the performance properties of two screed compositions. The

preparation of the mortars and the tests are the same as for examples 1 to 8.

5

[0073] TABLE 5

	Screed composition	Example 9	Example 10
A	ECOCCEM Dunkirk slag	9.5	5.4
D Ca(OH)_2	Tradical H90 (Précy)	0.9	0.9
C CaSO_4	Prestia Selecta	2.5	
C CaSO_4	Sulfacal Micro AF		4.5
B CAC	Ternal RG	5.51	8.1
H sand	Parcay 1/2	9.72	9.72
H sand	MI 0.1/1.2	38.1	38.1
H sand	Filler DC8	15	15
H sand	PE2LS	16.19	16.19
I polymer	I1: copolymer of vinyl acetate, vinyl chloride and ethylene, having a minimum film-forming temperature of 5°C	1.7	1.7
I polymer	I2: mixture of hydrocarbon liquids and polyglycols on an inert support having a bulk density of 330 g/l	0.05	0.05
I polymer	I3: modified polycarboxyl ethers having a density of between 300 and 600 kg/m ³	0.15	0.15
E	Lithium carbonate	0.1	0.1
K retarder	K1	0.1	0.3
J thickener	J: biopolymer gum	0.12	0.12
F alkalifying reagent	Sodium bicarbonate (pharm. Gr 13/27)	0.4	0.4
Mixing rate (%)		17	17
Initial flow (sec)		15	18

Slump flow (mm)	133	125
	/	125
	/	128
Settling	no	no
Setting time	12	40
DP	35	57
FP	55	75
Flexural strength 24 h (MPa)	3.4	5.24
Compressive strength 24 h (MPa)	8.4	11.5
Flexural strength 28 d (MPa)	/	/
Compressive strength 28 d (MPa)	14.72	20.76

[0074] EXAMPLES 11 TO 12

Table 6 below gives the formulas and performance properties of two adhesive mortar compositions. The preparation of the mortars and the tests are the same as for examples 1 to 10

5

[0075] TABLE 6

Components of the compositions according to the invention:	Components:	C2S1 ADHESIVE	
		Example 11	Example 12
		Percentage in the formula of the mortar	
		(%)	(%)
A	GGBS	22.5	22.5
B	CAC	2.5	2.5
C	C\$	4	6
D	Ca(OH) ₂	0.9	0.9
D	Portland cement	2	0
E	Li ₂ CO ₃	0.1	0.1
F	NaHCO ₃	0.4	0.4

		Percentages expressed at 100% relative to the binder	
		(%)	(%)
A	GGBS	69.4	69.4
B	CAC	7.7	7.7
C	C\$	12.3	18.5
D	Ca(OH) ₂	2.8	2.8
D	Portland cement	6.2	0
E	Li ₂ CO ₃	0.3	0.3
F	NaHCO ₃	1.2	1.2
Performance property	Adhesion in water (MPa)	0.75	0.76
	Ratio C/A	0.18	0.27
	Ratio C/B	1.6	2.4
	Ratio F/D	0.13	0.43

Claims

[Claim 1] Hydraulic binder, in particular for mortars, more particularly for adhesive mortars, comprising (in % by dry weight):

- A. at least 50 of at least one ground and granulated blast-furnace slag;
 - 5 B. more than 5, preferably from 5.5 to 30, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
 - C. more than 5, preferably from 6 to 30, and, more preferably still, from 8 to 20, of at least one source of sulfate ions;
 - D. between 1 and 5 of Ca(OH)_2 and/or of Portland cement;
 - 10 E. between 0.01 and 1 of at least one alkali metal carbonate, preferably Li_2CO_3 ;
 - F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof;
- subject to the following conditions:
- 15 (i) the amount of C is sufficient to allow the sulfate ions of C to react with B and with A;
 - (ii) the amount of F is sufficient so that its reaction with component D in the presence of water brings the pH of the resulting wet formulation to a value of not less than 12, preferably than 13, for a water-to-binder mixing rate of between 10 and 35% by weight.

[Claim 2] Hydraulic binder according to Claim 1, characterized in that

- 20 $0.1 < [\text{C}] / [\text{A}]$; preferably $0.1 \leq [\text{C}] / [\text{A}] \leq 1$, and, more preferably still, $0.1 \leq [\text{C}] / [\text{A}] \leq 0.3$.
- $0.5 < [\text{C}] / [\text{B}]$; preferably $1 \leq [\text{C}] / [\text{B}] \leq 3$, and, more preferably still, $1 \leq [\text{C}] / [\text{B}] \leq 2$.

[Claim 3] Hydraulic binder according to at least one of the preceding claims, characterized in that the source C of sulfate ions is selected from the group comprising – or better still consisting of –: natural or synthetic gypsum, calcium sulfate hemihydrate, bassanite, anhydrite, selenite, alabaster,

- 25 fibrous gypsum, saccharoidal gypsum, marine gypsum, gypsum flower, phosphogypsum, desulfurization gypsum, titanogypsum, citrogypsum, tartarogypsum, borogypsum, lactogypsum and mixtures thereof.

[Claim 4] Hydraulic binder according to at least one of the preceding claims, comprising (in % by dry weight):

- 30 A. 55 to 90, preferably 60 to 85, of at least one ground and granulated blast-furnace slag;
- B. 5.5 to 30, preferably 6 to 20, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- C. 6 to 30, preferably from 8 to 20, of at least one source of sulfate ions;
- D. 1 to 5, preferably 2 to 4, of Ca(OH)_2 and/or of Portland cement;
- 35 E. 0.01 to 1, preferably 0.1 to 0.5, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 0 to 10, preferably from 0 to 20, of at least one binder different from A, B and D, preferably selected

from the group comprising – or better still consisting of –: silica or silica-alumina binders, fly ashes, advantageously silica-alumina fly ashes, silica-calcium-alumina fly ashes, expanded or calcined clay dusts and/or metakaolins.

[Claim 5] Dry mortar composition, more particularly dry adhesive mortar, render or screed
5 composition, characterized in that it comprises a binder according to one of any of Claims 1 to 3.

[Claim 6] Composition according to Claim 5, characterized in that it is an adhesive mortar and in that it comprises (in % by dry weight):

- A. 10 to 50, preferably 15 to 40, of at least one ground and granulated blast-furnace slag;
- B. 0.5 to 20, preferably 1 to 15, of at least one calcium aluminate cement and/or of at least one
10 calcium sulfoaluminate cement;
- C. 1 to 20, preferably from 2 to 15, of at least one source of sulfate ions with
 $0.5 \leq [C] / [B] \leq 3$;
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- 15 F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;
- G. 30 to 80, preferably from 40 to 70, of at least one type of aggregates preferably selected from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime sands and
20 silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- H. 1 to 10, preferably 1 to 5, of at least one redispersible polymer;
- 25 I. 0.01 to 5, preferably 0.05 to 1, of at least one thickener;
- J. 0.01 to 0.5, preferably 0.05 to 0.3, of at least retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[Claim 7] Composition according to Claim 5, characterized in that it is a screed or a render and in
30 that it comprises (in % by dry weight):

- A. 3 to 50, preferably 4 to 30, of at least one ground and granulated blast-furnace slag;
- B. 0.5 to 20, preferably 1 to 15, of at least one calcium aluminate cement and/or of at least one calcium sulfoaluminate cement;
- C. 1 to 20, preferably from 2 to 15, of at least one source of sulfate ions with
35 $0.5 \leq [C] / [B] \leq 3$;
- D. 0.05 to 5, preferably 0.5 to 2, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 0.02 to 0.8, preferably 0.05 to 0.15, of Li_2CO_3 ;
- F. and at least one alkalifying reagent consisting of at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting

of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 ; and mixtures thereof, with NaHCO_3 being preferred;

- G. 30 to 80, preferably from 40 to 70, of at least one type of aggregates preferably selected from the group comprising – or better still consisting of –: mineral sands such as silica sands, lime sands and silica-lime sands, light mineral sands such as perlite, vermiculite, expanded glass beads, sands
 5 obtained from the recycling of mineral materials such as demolition concrete, ground glass, sands obtained from the recycling of organic materials such as ground tyres, ground polyurethanes, and mixtures thereof;
- H. 1 to 10, preferably 1 to 5, of at least one redispersible polymer;
- I. 0.01 to 5, preferably 0.05 to 1, of at least one thickener;
- 10 J. 0.01 to 0.5, preferably 0.05 to 0.3, of at least retarder, preferably selected from the group comprising – or better still consisting of –: tartaric acid and its salts, citric acid and its salts, gluconic acid and its salts, and mixtures thereof.

[Claim 8] Activating system for a hydraulic binder for mortars, more particularly for adhesive mortars, renders or screeds, characterized in that it comprises (in % by dry weight):

- 15 C. 60 to 93, preferably 70 to 90, of at least one source of sulfate ions;
- D. 5 to 25, preferably 8 to 20, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- E. 1 to 3 of Li_2CO_3 ;
- F. at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 and mixtures thereof;
- 20 and in that the binder comprises (in % by dry weight):
- A. 60 to 99, preferably 70 to 95, of at least one ground and granulated blast-furnace slag;
- B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or at least one calcium sulfoaluminate cement.

[Claim 9] Use of a binder according to at least one of Claims 1 to 4 in a dry mortar composition or
 25 wet mortar formulation, more particularly an adhesive mortar, render or screed composition or formulation.

[Claim 10] Use of an activating system comprising (in % by dry weight):

- C. 60 to 93, preferably 70 to 90, of at least one source of sulfate ions;
- D. 5 to 25, preferably 8 to 20, of $\text{Ca}(\text{OH})_2$ and/or of Portland cement;
- 30 E. 0.5 to 5, preferably 1 to 3 of Li_2CO_3 ;
- F. at least one alkali metal carbonate and/or bicarbonate, different from E, preferably selected from the group comprising – or better still consisting of –: NaHCO_3 ; Na_2CO_3 ; K_2CO_3 and mixtures thereof;
- for activating a hydraulic binder for mortars, in particular for adhesive mortars, said binder comprising (in % by dry weight):
- 35 A. 60 to 99, preferably 70 to 95, of at least one ground and granulated blast-furnace slag;
- B. 40 to 1, preferably from 30 to 5, and, more preferably still, from 6 to 20, of at least one calcium aluminate cement and/or at least one calcium sulfoaluminate cement;
- wherein C is employed in an amount sufficient to allow the sulfate ions of C to react with B and with A.