
Use of a hydraulic binder containing calcium aluminate for the production of a construction material

Description

The present invention relates to the use of a binder containing calcium aluminate
5 for the production of a construction material.

Driven by government investments, the construction industry has seen a steady increase in incoming orders in recent years and now accounts for a significant share of the manufacturing sector. With regard to the achievement of climate policy
10 goals, which have recently come increasingly into focus, the construction industry is therefore also increasingly required to pursue environmentally friendly and sustainable concepts. For this reason, the concept of sustainable construction has been established for some time, which pursues various approaches to carrying out construction measures while preserving the ecosystem and the environment.

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With regard to possible starting points, the factors that drive climate change most strongly are of particular interest. In addition to the necessarily high demand for fossil fuels in the construction industry, it is above all the high demand for constructing materials that significantly promotes climate change. In contrast to methods for reducing the demand for fossil fuels, the development of sustainable constructing materials still needs to be developed. For example, the production of currently known hydraulic binders or constructing materials is often still associated with a considerable use of natural resources and a high energy input. The durability of known hydraulic binders or of constructing materials produced from known hydraulic binders is also often in need of optimisation.

It is therefore the object of the present invention to at least partially overcome the aforementioned disadvantages of known products and systems used for the production of a constructing material. In particular, it is the object of the invention to provide a sustainable and environmentally friendly way of producing a versatile constructing material which can be produced simply and inexpensively.

The foregoing object is solved by a use having the features of the independent claim for use. Further features and details of the invention result from the respective dependent claims and the description.

Use of a hydraulic binder containing calcium aluminate for the production of a constructing material is provided according to the invention, wherein the hydraulic binder containing calcium aluminate is obtainable by a method in which a) a prepared amorphous residual material rich in aluminium oxide and/or aluminium hydroxide is heated after addition of a b) calcium ion-containing binder component and c) water.

In the context of the invention, a hydraulic binder is preferably understood to be a material which, after being mixed with water, independently solidifies and hardens as a result of chemical reactions with the mixing water and, after hardening, also remains solid and dimensionally stable under water. According to the invention, a residual material is understood to mean in particular a residue produced in a method for which no reuse is intended and which therefore has to be disposed of, sometimes in a time-consuming and cost-intensive manner.

In the context of the invention, processing can be understood in particular as a form of treatment comprising, for example, collection, filtering, drying, comminution or the like. In the context of the invention, an alumina-rich and/or alumina-hydroxide-rich residual material is understood in particular as a material having an alumina content or an alumina-hydroxide content (the sum of the alumina or alumina-hydroxide) of at least 5 wt.%, preferably of at least 30 wt.%, in particular of at least 50 wt.% -relative to the dry content of the material. It is understood here that the material may also be formed substantially in the form of only one of the two components.

It should be noted at this point in advance of the following explanations that, with respect to the indication of preferred proportions by weight of the components within a mixture, the person skilled in the art is quite capable of combining the ranges in such a way that the total proportion of all components of the mixture is 100 wt.%.

In the context of the present invention, it has been recognized that, in particular, by using a processed amorphous residual material rich in aluminum oxide and/or aluminum hydroxide, it is possible to produce in a simple and inexpensive manner a hydraulic binder which can be used in a variety of ways and at the same time makes a contribution to sustainable construction, the contribution in the present case being made in particular by conserving natural resources by using residual or waste materials for the production of the hydraulic binder, which would otherwise have to be disposed of in an elaborate and cost-intensive manner.

With regard to a simple processability as well as a high water retention capacity of the hydraulic binder, it can be provided in an objectively advantageous manner that the prepared amorphous residual material rich in aluminium oxide and/or aluminium hydroxide -has a degree of crystallization of less than 25 wt.%, preferably of less than 20 wt.%, in particular of less than 15 wt.%. The degree of crystallization is intended here to serve as a measure of the amorphous character of a material, the properties being antiproportional to one another. The degree of crystallization can be measured here, for example, by spectroscopic methods, DSC measurements or X-ray diffraction experiments.

With regard to a particularly simple, efficient and inexpensive possibility of using processed alumina-rich and/or alumina-hydroxide-rich residues, it can be advantageously provided according to the invention that the processed alumina-rich and/or alumina-hydroxide-rich residue is formed at least partially, preferably completely, in the form of drinking water treatment residues. Drinking water treatment residues have in this case in particular high aluminium oxide and/or aluminium hydroxide contents and are significantly less expensive to purify than other residues, such as for example waste water treatment residues or the like, in particular because they are less contaminated with pollutants. Due to the different contents of drinking water and wastewater, these (drinking water / wastewater) are not directly comparable.

In the context of a production of a mineral-based constructing material, it is further advantageous if the processed alumina-rich and/or alumina-hydroxide-rich residue is substantially free of organic material. As used herein, organic material means material comprising carbon compounds and not belonging to any of the following compound types: elemental carbon, anhydrous chalcogenides, carbonic acid, carbonates, carbides, cyanides, cyanates and thiocyanates. Substantially free means a residual content of preferably less than 2 wt.%, more preferably less than 0.5 wt.%, more preferably less than 0.1 wt.%.

In order to enable fast and simple processing of the hydraulic binder containing calcium aluminate, it may advantageously further be provided that the prepared alumina-rich and/or aluminum hydroxide-rich residual material is substantially anhydrous. Essentially anhydrous here means a water content of preferably less than 5% by weight, more preferably less than 2 wt.%, in particular less than 0.5 wt.%.

With regard to easy processability and a high water retention capacity of the hydraulic binder containing calcium aluminate, it can also be advantageously provided that the prepared alumina-rich and/or aluminum hydroxide-rich residual material has a particle size of less than 100 μm , preferably of less than 50 μm , in particular of less than 40 μm .

In the context of the highest possible cost savings and sustainability, it can also be advantageously provided in accordance with the invention that the processed residual material

rich in aluminium oxide and/or aluminium hydroxide is used in a proportion of 0.5 -65 wt.%, preferably in a proportion of 1 - 55 wt.%, in particular in a proportion of 2 - 45 wt.%, based on the total dry mass of the constructing material, or is contained in the constructing material.

- 5 With regard to ensuring immediate usability of the present processed alumina-rich and/or alumina-hydroxide-rich residual material, it may further be provided that the material is temperature-pretreated, for example by being pre-treated at a temperature of less than 700 °C, preferably of less than 650 °C, more preferably at a temperature between 650 °C and 350 °C, in particular at a temperature between 400 °C and 500 °C. Similarly, the residual material
10 may be air-flow pre-treated or pre-dewatered.

- With regard to the production of a constructing material with the shortest possible processing time, it can be provided in particular that an ettringite former, preferably a calcium-containing and/or sulfate-containing ettringite former, is added for the production of the constructing
15 material. In this case, the ettringite former can be used in particular in a proportion of 20-70% by weight relative to the dry weight of the constructing material. Preferably, the ettringite former can be formed in the form of calcium aluminate, calcium sulfoaluminate cement, sodium aluminate, alumina cement, aluminium sulphate, aluminium hydroxide or mixtures thereof.

- 20 With regard to high strength, rapid processability and variable adjustability of properties of the constructing material, the addition of Portland cement and/or hydrated lime and/or calcium oxide and/or calcium sulphate may be provided for the production of the constructing material according to the invention. Likewise, pozzolans, lime or similar substances may be added.

- 25 In order to achieve a constructing material with the shortest possible setting times, rapid setting combined with high early strength and shrinkage compensation, the constructing material may advantageously comprise a ternary binder, the ternary binder preferably comprising alumina cement, Portland cement and a sulphate carrier.

- 30 In this case, the ternary binder advantageously has a proportion of 20 – 70 wt.% of alumina cement, 10 – 40 wt.% of sulphate carrier and 0.2 – 20 wt.% of Portland cement, based on the total mass of the ternary binder.

In order to be able to ideally adjust the setting times of the constructing material, the sulfate carrier may preferably be -formed in the form of alpha calciumsulfate hemihydrate, beta calciumsulfate hemihydrate, anhydrite, calcium sulfate dihydrate or mixtures thereof.

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In order to improve the adjustability of the mechanical and processing properties of the constructing material, the constructing material can advantageously comprise a filler, wherein the filler can preferably be added in the constructing material in a proportion of 10 – 90 wt.%, particularly preferably in a proportion of 20 – 80 wt.%, in particular in a proportion of 30 – 70
10 wt.% relative to the total dry mass of the constructing material. It should be noted that with respect to the indication of preferred ranges of a plurality of components, the skilled person is well able to combine the ranges in such a way that the total proportion of all components is 100%.

15 Here, the filler may preferably have a particle size of less than 2 mm, more preferably of less than 1 mm, in particular a particle size of 10 - 500 µm. In addition, the filler may be in the form of different variants, such as, for example, limestone powder, quartz sand, marble, chalk, clay, marl, talc or light fillers, such as hollow microspheres made of glass, ceramic or plastic or light fillers, such as expanded glass, expanded mica, expanded perlite, expanded slate, expanded
20 clay, coal fly ash, brick chippings, natural pumice, tuff, lava, slag pumice, boiler sand or a mixture thereof.

For further preferably tailor-made adjustability of the properties of the constructing material, the addition of additives can be provided for the production of the constructing material,
25 wherein the additives can preferably be added in a proportion of 0.001 – 10 wt.%, particularly preferably in a proportion of 0.005 – 5 wt.%, in particular in a proportion of 0.01 - 2.5 wt.%, based on the total dry mass of the constructing material.

With regard to a particularly diverse adjustability of the properties of the constructing material,
30 the additives may be formed, for example, in the form of liquefiers, retarders, accelerators, actuators, stabilizers, defoamers or sealants. The liquefiers may preferably be present in the constructing material in an amount of from 0.001 to 5 wt.%, and are preferably provided to

reduce the amount of water required during mixing of the constructing material, as well as to provide high early strength development. The plasticizers or the superplasticizers or leveling agents may in this case be formed in particular in the form of modified plasticizers based on polycarboxylate ethers, on melamine sulfonate, on casein or on saturated or unsaturated mono- or dicarboxylic acid derivatives or on oxyalkylene glycol alkenyl ethers and/or esters. The retarders may further preferably be present at a level of from 0.001 to 2 wt.% in the constructing material and advantageously be formed in the form of tartaric acid, citric acid or one or more of the salts thereof. The accelerators may further preferably be formed in the form of setting accelerators and may be present, for example, in a proportion of 0.001 to 2 wt.% in the constructing material. In particular, the accelerators may be based on alkali carbonates, such as LiCO_3 or the like. The stabilizing agents may further advantageously be present in the constructing material in a proportion of 0.001 to 2 wt.% and may be formed, for example, in the form of heteropolysaccharides, cellulose, cellulose derivatives, such as hydroxycellulose or the like. The defoamers may further be present, for example, at a level of 0.001 to 1 wt.% in the constructing material. In addition to the additives mentioned, other additives, such as thickeners, color pigments, reducing agents, air-entraining agents, processing aids, hydrophobing agents, wetting agents, biocides, fungicides, algicides or flame retardants or the like may also be present in the constructing material.

With regard to the production of a rapidly hardening, water-impermeable, tensile-bending and pressure-resistant constructing material, it can be further provided that the addition of an epoxy resin and an epoxy hardener is provided for the production of the constructing material, wherein the epoxy resin and the epoxy hardener can be added in total preferably in a proportion of 10 - 60 wt.% relative to the total dry mass of the constructing material.

In order, in particular, to improve the adhesion, flexibility and processability of the constructing material, it can also be provided that the constructing material comprises a plastic dispersion powder, the plastic dispersion powder preferably being present in the constructing material in a proportion of 0.1 – 20 wt.%, particularly preferably in a proportion of 0.5 – 10 wt.%, in particular in a proportion of 1 to 5 wt.%, based on the total dry mass of the constructing material.

The plastic dispersion powder may in this case be based, for example, on vinyl or acrylate polymers, in particular on a polyvinyl acetate, a polyvinyl versatate, a polystyrene acrylate, a polyacrylate, a polyvinyl alcohol, a polyvinyl propionate, a polyvinyl chloride, a polyethylene, a polypropylene, a butyl acrylate or a mixture thereof.

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In order to improve the resistance of the constructing material to deformation, in particular to bending and tensile stress, it is further conceivable that the addition of a fibrous material is provided for the production of the constructing material, the fibrous material preferably being added in a proportion of 0.01 – 5 wt.%, particularly preferably in a proportion of 0.1 – 3 wt.%,
10 in particular in a proportion of 1 – 2 wt.%, based on the total dry mass of the constructing material.

With regard to effectively improving resistance to deformation, it is also conceivable that the fibrous material comprises fibres of a length of up to 2 mm, preferably of up to 3 mm, in
15 particular of up to 5 mm.

With regard to easy miscibility and processability of the constructing material, it can be advantageously provided in accordance with the invention that the constructing material is formed in the form of a screed, a mortar, a compound or a tile adhesive. In this regard, the
20 constructing materials may be particularly suitable for laying natural stones, bricks, tiles, slabs or other covering materials, such as mats, wooden flooring, parquet, carpet, laminate and the like. The screed may further be formed as a cement screed or a synthetic resin screed and may be applied in the form of a flowing or dry screed. The mortar may also be formed in the form of a cement-based mortar or a synthetic resin mortar, and may be in the form of a grout
25 or thin-bed mortar. The compounds may further be formed, for example, in the form of a floor, wall or ceiling filler, whereas the tile adhesive may also be formed as a floor or wall tile adhesive and may be cement-based or synthetic resin-based.

Further advantages, features and details of the invention will be apparent from the following
30 description, in which embodiments of the invention are described in detail. The features mentioned in the claims and in the description may be essential to the invention individually or in any combination.

Examples of embodiments:

Some exemplary formulations (dry compositions) for constructing materials according to the invention are given below, which can be prepared starting from the use of the hydraulic binder containing calcium aluminate according to the invention (hydraulic binder I) with the addition of the further components listed. The corresponding "ready-to-use" constructing material can then be produced from these proposed dry compositions by adding water. The proportion of water in this case can preferably be 10 - 150 wt.% relative to the total dry mass of the constructing materials. The designation "hydraulic binder I" is intended to distinguish the hydraulic binder containing calcium aluminate according to the invention in particular from other hydraulic binders, such as Portland cement or alumina cement.

Tile Adhesive:

15	Hydraulic binder I:	30 wt. %
	Portland cement:	15 wt. %
	Sand:	51.6 wt.-%
	Accelerator:	1 wt. %
	Cellulose ether:	0.5 wt. %
20	Dispersible powder:	1.8 wt. %
	Fibrous material:	0.1 wt. %

Putty:

	Hydraulic binder I:	16.5 wt. %
25	Portland cement:	5.5 wt. %
	Alumina cement:	5 wt. %
	CaSO ₄ - α -hemihydrate:	9 wt. %
	Sand:	26 wt. %
	Limestone powder:	24 wt. %
30	Lightweight aggregates:	10 wt. %
	Dispersible powder:	3 wt. %

Casein:	0.2 wt. %
Condenser:	0.5 wt. %
Stabilizer:	0.02 wt. %
Retardant:	0.07 wt. %

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Screed:

Hydraulic binder I:	11.6 wt. %
Alumina cement:	4 wt. %
Portland cement:	10.4 wt. %
CaSO ₄ - α -hemihydrate:	11 wt. %
Sand:	62 wt. %
Superplasticizer:	0.05 wt. %
Setting accelerator:	0.15 wt. %
Retardant:	0.1 wt. %

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Synthetic resin mortar:

Hydraulic binder I:	29.2 wt. %
Synthetic resin:	30 wt. %
Hardener:	3.3 wt. %
CaSO ₄ - α -hemihydrate:	14.6 wt. %
Alumina cement:	17.3 wt. %
Portland cement:	4.8 wt. %
Setting accelerator:	0.4 wt. %
Retardant:	0.26 wt. %

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The constructing materials according to the invention listed in the embodiments are not only versatile in use and simple and inexpensive to produce, but also simultaneously make a contribution to sustainable construction, which is provided in particular by the fact that resources are conserved for the production of the constructing materials by using residual or waste materials for production, which would otherwise have to be disposed of in an elaborate and cost-intensive manner.

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Claims

1. A use of a hydraulic binder containing calcium aluminate, obtainable by a method in which
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(a) processed amorphous alumina-rich and/or alumina-hydroxide-rich residue after
addition of an

(b) calcium ion-containing binder component; and

(c) water is heated,

for the production of a constructing material.

2. The use according to claim 1,

characterized in that

the prepared amorphous alumina-rich and/or alumina-hydroxide-rich residue has a degree
of crystallization of less than 25%, preferably of less than 20%, in particular of less than
15%.

3. The use according to claim 1 or 2,

characterized in that

the processed amorphous alumina-rich and/or alumina-hydroxide-rich residue is formed in
the form of a drinking water treatment residue.

4. The use according to any one of the preceding claims,

characterized in that

in that the hydraulic binder containing calcium aluminate has a residual proportion of
organic material, the residual proportion preferably being greater than 0.5 wt.%, particularly
preferably greater than 1.5 wt.%, in particular greater than 3 wt.%, based on the total mass
of the hydraulic binder.

5. The use according to any one of the preceding claims,

characterized in that

the hydraulic binder containing calcium aluminate is substantially anhydrous.

6. The use according to any one of the preceding claims,
characterized in that
the hydraulic binder containing calcium aluminate has a particle size of less than 100 μm ,
5 preferably less than 50 μm , in particular less than 40 μm .
7. The use according to any one of the preceding claims,
characterized in that
the hydraulic binder containing calcium aluminate is present in the constructing material in
10 a proportion of 0.5 to 65 wt.%, preferably 1 to 55 wt.%, in particular 2 to 45 wt.%, based
on the total dry mass.
8. The use according to any one of the preceding claims,
characterized in that
15 the addition of an ettringite former, preferably a calcium-containing and/or sulfate-
containing ettringite former, is provided for the production of the constructing material.
9. The use according to any one of the preceding claims,
characterized in that
20 the addition of Portland cement and/or hydrated lime and/or calcium oxide and/or calcium
sulphate is provided for the production of the constructing material.
10. The use according to any one of the preceding claims,
characterized in that
25 the hydraulic binder containing calcium aluminate is formed in the form of a ternary binder,
the ternary binder comprising, in addition to the calcium aluminate-containing component,
Portland cement and a sulphate carrier.
11. The use according to any one of the preceding claims,
30 **characterized in that**

the ternary binder has a proportion of 20 to 70 wt.% of the calcium aluminate-containing component, 10 to 40 wt.% of sulfate carrier and 0.2 to 20 wt.% of Portland cement, based on the total mass of the ternary binder.

5 12. The use according to any one of the preceding claims,

characterized in that

the sulphate carrier -is formed in the form of alpha calciumsulphate hemihydrate, beta calciumsulphate hemihydrate, anhydrite, calcium sulphate dihydrate or mixtures thereof.

10 13. The use according to any one of the preceding claims,

characterized in that

the addition of a filler is provided for the production of the constructing material, the filler preferably being added in a proportion of 10 to 90 wt.%, particularly preferably in a proportion of 20 to 80 wt.%, in particular in a proportion of 30 to 70 wt.%, based on the
15 total dry mass of the constructing material.

14. The use according to any one of the preceding claims,

characterized in that

the filler is formed in the form of limestone powder, quartz sand, marble, chalk, clay, marl,
20 talc or light fillers, such as hollow microspheres of glass, ceramic or plastic, or light fillers, such as expanded glass, expanded mica, expanded perlite, expanded slate, expanded clay, coal fly ash, brick chippings, natural pumice, tuff, lava, slag pumice, boiler sand or a mixture thereof.

25 15. The use according to any one of the preceding claims,

characterized in that

the addition of additives is provided for the production of the constructing material, the additives preferably being added in a proportion of 0.001 to 10 wt.%, particularly preferably in a proportion of 0.005 to 5 wt.%, in particular in a proportion of 0.01 to 2.5 wt.%, based
30 on the total dry mass of the constructing material.

16. The use according to any one of the preceding claims,

characterized in that

the additives are in the form of liquefiers, retarders, accelerators, actuators, stabilizers, defoamers or sealants.

5 17. The use according to any one of the preceding claims,

characterized in that

the addition of an epoxy resin and an epoxy hardener is provided for the production of the constructing material, wherein the epoxy resin and the epoxy hardener are preferably added in a total proportion of 10 to 60 wt.% relative to the total dry mass of the constructing material.

18. The use according to any one of the preceding claims,

characterized in that

the addition of plastic dispersion powder is provided for the production of the constructing material, the plastic dispersion powder preferably being added in a proportion of 0.1 to 20 wt.%, particularly preferably in a proportion of 0.5 to 10 wt.%, -in particular in a proportion of 1 to 5 wt.%, based on the total dry mass of the constructing material.

19. The use according to any one of the preceding claims,

characterized in that

the synthetic material dispersion powder is formed on the basis of vinyl or acrylate polymers, in particular on the basis of a polyvinyl acetate, a polyvinyl versatate, a polystyrene acrylate, a polyacrylate, a polyvinyl alcohol, a polyvinyl propionate, a polyvinyl chloride, a polyethylene, a polypropylene, a butyl acrylate or a mixture thereof.

20. The use according to any one of the preceding claims,

characterized in that

the addition of a fibrous material is provided for the production of the constructing material, the fibrous material preferably being added in a proportion of 0.01 to 5 wt.%, particularly preferably in a proportion of 0.1 to 3 wt.%, in particular in a proportion of 1 to 2 wt.%, based on the total dry mass of the constructing material.

21. The use according to claim 21,

characterized in that

the fibrous material has fibres of a length of up to 2 mm, preferably of up to 3 mm, in particular of up to 5 mm.

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22. The use according to any one of the preceding claims,

characterized in that

the constructing material is formed in the form of a screed, mortar, filler or tile adhesive.