

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

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25. Aug. 2017

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing
(day/month/year)

21.08.2017

Applicant's or agent's file reference
48 112

IMPORTANT NOTIFICATION

International application No.
PCT/IB2016/000665

International filing date (day/month/year)
18.05.2016

Priority date (day/month/year)
26.05.2015

Applicant
Holcim Technology Ltd.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international
preliminary examining authority:



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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 48 112	FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/IB2016/000665	International filing date (day/month/year) 18.05.2016	Priority date (day/month/year) 26.05.2015	
International Patent Classification (IPC) or national classification and IPC INV. C04B28/04			
Applicant Holcim Technology Ltd.			
1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of <u>8</u> sheets, including this cover sheet. 3. This report is also accompanied by ANNEXES, comprising: a. ☒ (sent to the applicant and to the International Bureau) a total of <u>5</u> sheets, as follows: ☒ sheets of the description, claims and/or drawings which have been amended and/or sheets containing rectifications authorized by this Authority, unless those sheets were superseded or cancelled, and any accompanying letters (see Rules 46.5, 66.8, 70.16, 91.2, and Section 607 of the Administrative Instructions). ☐ sheets containing rectifications, where the decision was made by this Authority not to take them into account because they were not authorized by or notified to this Authority at the time when this Authority began to draw up this report, and any accompanying letters (Rules 66.4bis, 70.2(e), 70.16 and 91.2). ☐ superseded sheets and any accompanying letters, where this Authority either considers that the superseding sheets contain an amendment that goes beyond the disclosure in the international application as filed, or the superseding sheets were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in item 4 of Box No. I and the Supplemental Box (see Rule 70.16(b)). b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing, in the form of an Annex C/ST.25 text file, as indicated in the Supplemental Box Relating to Sequence Listing (see paragraph 3ter of Annex C of the Administrative Instructions).			
4. This report contains indications relating to the following items: ☒ Box No. I Basis of the report ☐ Box No. II Priority ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability ☐ Box No. IV Lack of unity of invention ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement ☐ Box No. VI Certain documents cited ☐ Box No. VII Certain defects in the international application ☒ Box No. VIII Certain observations on the international application			
Date of submission of the demand 27.03.2017		Date of completion of this report 21.08.2017	
Name and mailing address of the international preliminary examining authority:  European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016		Authorized officer Kolb, Ulrike Telephone No. +31 70 340-9597	



**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/IB2016/000665

Box No. I Basis of the report

1. With regard to the **language**, this report is based on
- ☒ the international application in the language in which it was filed
 - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3(a) and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4(a))
 - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a) and (b))
2. With regard to the **elements*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

Description, Pages

1-11 as originally filed

Claims, Numbers

1-13 filed with telefax on 12-06-2017

- ☐ a sequence listing - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since either they are considered to go beyond the disclosure as filed, or they were not accompanied by a letter indicating the basis for the amendments in the application as filed, as indicated in the Supplemental Box (Rules 70.2(c) and (c-bis)):
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
5. ☐ This report has been established:
- ☐ taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rules 66.1(d-bis) and 70.2(e)).
 - ☐ without taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rules 66.4bis and 70.2(e)).

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/B2016/000665

6. ☒ With regard to top-up searches (Rules 66.1 *ter* and 70.2(f)):
- ☒ A top-up search was carried out by this Authority on 04.04.2017 (all discovered documents are listed in the Supplemental Box Relating to Top-up Search).
 - ☐ Additional relevant documents have been discovered during the top-up search.
 - ☐ No top-up search was carried out by this Authority because it would serve no useful purpose.
7. ☐ Supplementary international search report(s) from Authority(ies) has/have been received and taken into account in establishing this report (Rule 45bis.8(b) and (c)).

* If item 4 applies, some or all of those sheets may be marked "superseded".

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>1-13</u>
	No: Claims	
Inventive step (IS)	Yes: Claims	<u>1-13</u>
	No: Claims	
Industrial applicability (IA)	Yes: Claims	<u>1-13</u>
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference is made to the following documents:

- D1 FR 3 006 311 A1 (ITALCEMENTI SPA [IT]) 5 December 2014
- D2 WO 2011/053103 A2 (OSLEJS JANIS [LV]; KRAVALIS KASPARS [LV]; PRIMETEH AS [LV]) 5 May 2011
- D3 WO 2014/015289 A1 (U S CONCRETE INC [US]) 23 January 2014
- D4 DATABASE WPI
Week 199642
Thomson Scientific, London, GB;
AN 1996-421759
& JP H08 208302 A (ASAHI KASEI KK) 13 August 1996 (1996-08-13); &
JP H08 208302 A (ASAHI CHEMICAL IND) 13 August 1996
- D5 US 2009/301009 A1 (FALK JOERGEN [SE] ET AL) 10 December 2009

1.2 The following documents have been cited by the applicant:

- D7 US 2011/015306 A1 20 January 2011
- D8 US 2012/097072 A1 26 April 2012

We refer to your letter dated 12.06.2017. We would like to draw the attention of the applicant to the objection under point 5.

2 Independent claim

Concrete composition comprising

- 140 - 160 l/m³ water (w/c = 0,45- 0,57)
- 280 - 310 kg/m³ hydraulic binder comprising a Portland cement of high reactivity

having a Blaine fineness of 4500-6500 cm²/g

- sand
- aggregates
- 3 - 4 l/m³ shrinkage reducing admixture being an organic admixture.

3.1 The present application meets the criteria of Article 33(2) PCT, because the subject-matter of claim 1 is new with respect to D1 and D2.

3.2.1 D1 discloses (abstract; page 2, line 7 - line 14; page 2, line 19 - page 3, line 6; page 4, line 12 - line 28; page 5, line 19 - line 23; page 7, line 4 - line 12; page 7, line 32 - page 10, line 30; page 12, line 16 - line 17) a self-placing concrete composition. Example 3 defines a mixture comprising:

- w/c = 0,5
- Portland cement of high reactivity (Blaine < 6000 g/cm²)
- sand
- aggregates
- polycarboxylate ether superplasticizer
- no shrinkage reducing admixture.

3.2.2 The subject-matter of claim 1 mainly differs from the product known from D1 in that 3 - 4 liter per cubic meter of shrinkage reducing admixture are mandatory present in the composition.

3.3.1 D2 discloses in example 4 a zero shrinkage after 150 days of hardening concrete composition for a floor slab comprising 160 l/m³ water, 320 kg/m³ Portland CEM III (of increased fineness and thus, relatively higher reactivity; commonly 4.150 cm²/g Blaine fineness), 1890 kg/m³ sandstone, 30 kg/m³ steel fiber, 12 kg/m³ ethylene glycol (density 1,11 g/cm³ => 10,81 l/m³), 4 kg/m³ naphthalene plasticizer. CEM III is known for providing relatively high early strength, especially after one day; likewise, it reaches a higher final strength than CEM I or CEM II.

D2 suggests (p. 3, l. 3 - 5; ex. 6: 50 kg/m³ CaO and 8 kg/m³ ethylene glycol) the combination of two shrinkage reducing additives, namely ethylene glycol and free lime (CaO). Furthermore, it is suggested (p. 3, l. 20 - 30) to add 5 - 15 kg/m³ nano-sized pozzolanic dust. D2 lists (cl. 2) polycarboxylate as water reducing agent alternative to naphthalene. D2 remains silent about the drying time of the concrete.

3.3.2 The subject-matter of claim 1 therefore differs from this known product known from D2 in that

- a significantly smaller amount of the shrinkage reducing additive glycol ethylene is present in the composition, namely maximum 4 l/m³ instead of more than double 10,81 l/m³.
- the amount of Portland CEM III is limited to a smaller amount, namely 310 kg/m³ instead of 320 kg/m³; thus, less binder is present per cubic meter of concrete.
- overall, the ratio of water, binder, shrinkage reducing agent per cubic meter is different

4.1 The present application meets the criteria of Article 33(3) PCT, because the subject-matter of claim 1 involves an inventive step starting from D7.

4.2 D7 is regarded as being the prior art closest to the subject-matter of claim 1, since it solves the same problem, namely to provide concrete compositions with reduced drying times.

D7 discloses in table 8 (see example 5 in paragraphs 166 - 167) the compositions of samples 12 and 13 which comprise 740 lbs Hanson cement, 60 lbs pozzolan (either silica fume or metakaolin), 1200 lbs fine sand, 1950 lbs coarse sand, 16,2 oz/lbs superplasticizer of polycarboxylate type, 0,5 oz defoamer, w/c ratio 0,23 resp. 0,25. The drying time to achieve 75% relative humidity was 28 days.

4.3 The subject-matter of claim 1 differs from the composition known from D7 in that

- a significantly higher water/cement ratio is used, namely 0,45- 0,57
- a shrinkage reducing agent is mandatory present in an amount of 3 - 4 l/m³

4.4.1 The technical effect relating to these differences is explained by the applicant in his letter dated 27.03.2017 as follows:

- In the fresh state, the rheology of the concrete composition according to the invention is similar to that of conventional concrete for floor applications (reduced viscosity, reduced slump and reduced setting time).
- The setting time and strength development of the concrete composition according to the invention is also similar to that of conventional concrete.
- When the curing has taken place, the drying times of the concrete composition according the invention are significantly reduced since the use of shrinkage reducer admixtures under specific conditions of the water and binder amounts per cubic meter of concrete acts as an accelerator for the drying of the concrete.
- Furthermore, the concrete composition has no stickiness.

4.4.2 Mix #5 comprises all essential features and mix #6 combines the shrinkage reducing agent with CaO. In both cases, a water reducer and slag as supplementary cementitious material are present in the mixes. It was shown, that in comparison to mix #1, which does not comprise a shrinkage reducing agent and required 100 days to dry to 80% humidity, mix #5 requires only 39 days to reach the same level of humidity.

4.4.3 No comparative examples were provided with respect to the mixture known from D7, but the problem was plausibly explained in the description (p. 4, l. 12-22). No example was provided for a mix that shows a technical effect when only the components defined as essential in current claim 1 are present.

4.5 According the applicant (see his letter dated 27.03.2017), the subjective technical problem on which the invention is based is: to provide a non-tacky concrete composition which combines several opposing properties, namely reduced drying times once hardened while at the same time good workability of the fresh concrete is provided and bleeding water is generated at the concrete surface.

4.6 The technical solution defined in claim 1 is regarded as to involve an inventive step, since the skilled person, starting from the composition known from D7, would not find any hint in the relevant state of the art D2 - D5, to carry out significant modifications and to add a shrinkage reducing agent in combination with a comparably higher amount of water.

Re Item VIII

Certain observations on the international application

5 Clarity (Art. 6 PCT)

Dependent claim 4 as well as the corresponding passage in the description (p. 6, l. 27 - p. 7, l. 2) need to be deleted, since they attempt to define a composition that lies outside the range defined in claim 1. Thus, the requirements for a dependent claim are not fulfilled.

6 Miscellaneous

**INTERNATIONAL PRELIMINARY
REPORT ON PATENTABILITY
(SEPARATE SHEET)**

International application No.

PCT/IB2016/000665

6.1 In table 1, only mixes #5 and #6 are according the invention. All other mixes should be tagged "comparative" or "not according the invention".

6.2 The description has to be strictly adapted to the amended set of claims to be submitted.

12. Jun 2017 13:22

Haffner & Keschmann

Nr. 1189 S. 1/9

**HAFFNER
&
KESCHMANN**

PATENTANWÄLTE

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Wien, am 12.06.2017

Betreff:

International Patent Application PCT/IB2016/000665
Holcim Technology Ltd.
Unser Zeichen: 48112 mr

Response to the written opinion (PCT Rule 66) of April 13, 2017

Dear Ladies and Sirs,

Applicant may comment on the objections raised in the Written Opinion of the International Preliminary Examining Authority as follows.

The novelty and inventive step objections with regard to cited documents D1 to D6 could be overcome via the arguments and amendments as filed accompanying the Request for international preliminary examination.

In order to overcome the clarity objections as raised in the above mentioned written opinion the following amendments in the claim version as actually on file were performed:

- Incorporation of claim 5 (former claim 6), whereby the shrinkage reducing admixture is an organic admixture based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants, in claim 1.

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12. Juni 2017 13:22

Haffner & Keschmann

Nr. 1189 S. 2/9

- 2 -

- Incorporation of claim 8, whereby the Portland cement has a Blaine fineness of 4500-6500 cm²/g, in claim 1.

- Claim 15 was deleted.

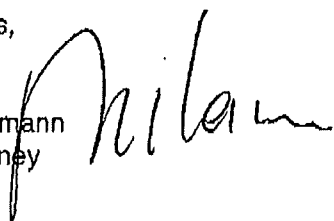
With regard to the objection that the presence of a water reducer seems to be an essential feature for obtaining a reduced drying time and that thus the additional technical features as defined in claims 11 and 12 (new claims 9 and 10) are considered to be essential and need to be incorporated into claim 1 we may comment as follows.

The opinion of the International Preliminary Examining Authority cannot be followed. Due to the fact that in the examples according to the invention, i.e. examples 5 and 6, water reducer is added to the mixture, it can not be concluded that a water reducer is essential for the present invention. The water reducer serves to improve the workability of the concrete mass and is therefore preferable (cf. page 7, lines 21-26). However, the water reducing agent is not considered essential for achieving the inventive effects.

Considering the aforementioned arguments and amendments applicant requests to issue a positive International preliminary report on patentability. If there are any remaining issues, the Examiner is encouraged to issue another written opinion or to contact the undersigned by phone.

Best regards,

Marc Keschmann
Patent Attorney



Encl.

Amended set of claims

Amended set of claims with mark-ups

Amended Claims:

1. Concrete composition comprising, in a mixture with water, a hydraulic binder, sand and aggregates, wherein the
5 hydraulic binder comprises a Portland cement of high reactivity, wherein the Portland cement has a Blaine fineness of 4500-6500 cm²/g, characterized in that the hydraulic binder is present in an amount of 280-310 kg per cubic meter of concrete, that a shrinkage reducing
10 admixture is present in an amount of 3-4 L per cubic meter of concrete, wherein the shrinkage reducing admixture is an organic admixture, in particular based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants
15 and that water is present in an amount of 140-160 l per cubic meter of concrete.
2. Concrete composition according to claim 1, wherein the reactivity of the hydraulic binder is selected such as to
20 obtain a 28d compressive strength of the concrete of > 52,5 MPa.
3. Concrete composition according to claim 1 or 2, wherein the reactivity of the hydraulic binder is selected
25 such as to obtain a 1d compressive strength of the concrete of > 20 MPa.
4. Concrete composition according to any one of claims 1 to 3, wherein the shrinkage reducing admixture is present
30 in an amount of 0-1 L per cubic meter of concrete and the hydraulic binder is present in an amount of 310-340 kg per cubic meter of concrete.

5. Concrete composition according to any one of claims 1 to 4, wherein the hydraulic binder comprises a supplementary cementitious material, preferably ground granulated blast furnace slag, fly ash, pozzolans, ground limestone or mixtures thereof.
6. Concrete composition according to claim 5, wherein the supplementary cementitious material is present in an amount of 1-20 wt.-% of the hydraulic binder.
7. Concrete composition according to claim 5 or 6, wherein the supplementary cementitious material has a Blaine fineness of 4500-6500 cm²/g.
8. Concrete composition according to any one of claims 1 to 7, further comprising an expanding agent, such as CaO, preferably in an amount of 0,5-3 wt.-% of the hydraulic binder.
9. Concrete composition according to any one of claims 1 to 8, further comprising a water reducing agent, which is preferably present in an amount between 0,4 and 1 wt.-% of the hydraulic binder.
10. Concrete composition according to claim 9, wherein the water reducing agent comprises poly-carboxylate ether or polynaphthalene sulfonate.
11. Concrete composition according to any one of claims 1 to 10, wherein the amount of water and hydraulic binder is selected so as to reach a flow of the freshly mixed concrete at 10 min of at least 100 mm +/- 10 mm.

12. Concrete composition according to any one of claims 1
to 11, wherein the concrete, within less than 30-50 days,
in particular less than 30-40 days, after placing has a
5 relative humidity of 80% according to ASTM F2170.

13. A construction element comprising concrete or made of
concrete produced using a concrete mix composition
according to any one of claims 1 to 12.

10

From the INTERNATIONAL BUREAU

PCTNOTIFICATION CONCERNING SUBMISSION,
OBTENTION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

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Date of mailing (day/month/year) 06 June 2016 (06.06.2016)	
Applicant's or agent's file reference 48 112	IMPORTANT NOTIFICATION
International application No. PCT/IB2016/000665	International filing date (day/month/year) 18 May 2016 (18.05.2016)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 26 May 2015 (26.05.2015)
Applicant HOLCIM TECHNOLOGY LTD	

The applicant is hereby notified of the date of receipt (or of obtaining by the International Bureau) of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to the date of receipt, **the priority document concerned was submitted or transmitted to or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis)**. This Form replaces any previously issued notification concerning submission, transmittal or obtaining of priority documents.

Priority datePriority application No.Country or regional Office
or PCT receiving OfficeDate of receipt
of priority document

26 May 2015 (26.05.2015)

A 329/2015

AT

30 May 2016 (30.05.2016)

The letters "NR" denote a priority document which, on the date of mailing of this Form, had not yet been received or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis). Where the applicant has failed to either submit, request to prepare and transmit, or to request the International Bureau to obtain the priority document within the applicable time limit under that Rule, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

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Published:

— with international search report (Art. 21(3))

(54) Title: CONCRETE COMPOSITION WITH REDUCED DRYING TIME ONCE HARDENED

(57) Abstract: A concrete with reduced drying time once hardened made from a composition comprising: - 140 - 160 l/m³ water - 280 - 340 kg/m³ highly reactive Portland cement of Blaine fineness 4500-6500 cm²/g, and - optionally a supplementary cementitious material, - sand, - aggregates, - 0 - 4 l/m³ shrinkage reducing admixture polyethylene glycol or polypropylen glycol - a water reducing agent and - optionally calcium oxide as expanding agent. The concrete has a 1d compressive strength of > 20 MPa.



CONCRETE COMPOSITION WITH REDUCED DRYING TIME ONCE HARDENED

The invention refers to a concrete composition comprising
in a mixture with water, a hydraulic binder, sand,
5 aggregates, with reduced drying time once hardened.

Further, the invention refers to a hydraulic binder
composition for producing a concrete with reduced drying
time, while being able to provide a good amount of bleeding
10 water, excellent fresh concrete behaviour, and comprising
ordinary Portland cement, optionally a supplementary
cementitious material and an expanding agent.

Concrete is a very widely used construction material with
15 high strength and good durability. In addition to
aggregates and water, it also contains Portland cement as a
hydraulic binder, which produces strength-forming phases by
reacting and solidifying in contact with water. Concrete
based on Portland cement clinker is thus one of the most
20 important construction materials worldwide.

When Portland cement formulations are mixed with water,
hydration reactions immediately begin to form minerals.
These reactions generate heat and form a dense
25 microstructure of cement hydrates that gives concrete its
final strength and durability properties. The water added
to a concrete composition is also a chemical reactant that
first acts by dissolving the mineral constituents of
Portland cement. As these minerals dissolve, the
30 concentration of mainly calcium, hydroxide, silicate,
aluminate, and sulphate ions increase in the water of the
fresh concrete composition. When the concentration has
reached a sufficiently high level, a point of super-

saturation, the ions precipitate in the form of mineral hydrates, such as ettringite, or CSH gel. These hydrates contain large amounts of water trapped in their respective mineral structures.

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A cubic metre of concrete typically contains between 140 and 200 L of water, and between 280 and 450 kg of hydraulic binder. In most concrete compositions, the total amount of water exceeds the stoichiometry of the hydration reactions of Portland cement, which means that even after its final setting time, large amounts of free water remain in the concrete structure. This water fills capillary pores within the concrete mass, and gradually evaporates over time.

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15 When concrete is used for interior floors, in many cases the hardened concrete surface is afterwards covered by protective or decorative layers such as paint, sealants, carpet, or wood. This additional layer forms a barrier to water migration and in case of large amounts of free water still within the concrete structure, the protective or decorative layers suffer chemical and physical changes upon water migration. The final results are uneven changes of the colour of the coating, reduction of its adherence to the underlying concrete surface, or swelling of wooden floorings. In all these situations, the concrete coating fails, and needs to be replaced. The costs and delays associated are potentially a major issue for the construction industry. To prevent this, the relative humidity within a concrete mass is measured according to the procedures described in the ASTM standards F2170 and F2420, and concrete floors should be covered once their relative humidity decreases to below a threshold value of 80%. In practice, the drying of concrete floors is slow: it

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can typically require 6 to 8 weeks for the relative humidity to reach 80%. It is a purpose of this invention to reduce these drying times.

5 US 2011/0015306 and US 2012/097072 disclose concrete compositions with reduced drying times. The concretes described are characterised by a relatively low water cement ratio of between 0,2 and 0,4, the addition of fine cementitious materials of high reactivity, the use of a
10 standard shrinkage reducing admixture, and the use of a vapour attenuation agent selected from alkali metal halide salts, alkali metal nitrate salts and alkali metal nitride salts. The water cement ratio is kept as low as possible to ensure that the amount of free water in the concrete slab
15 is kept low. The fine cementitious materials of increased reactivity increase the formation of hydrates during the early stages of the hardening reactions; increasing in turn the ratio between water trapped in mineral hydrates and free water in the pore solutions. The preferred fine
20 materials are fine calcium carbonates or fine silica fume. Accelerators such as sodium nitrite or calcium silicate are used for the same purpose, as they increase the formation of hydrates. A standard shrinkage reducing agent such as polypropylene glycol is said to favour the formation of a
25 denser network of smaller capillary pores in the concrete structure, facilitation the migration of free water to the surface of concrete where it evaporates. In the case of lightweight concrete slabs, synthetic polymer particles are preferred to lightweight aggregates since these later
30 products considerably slow the drying of concrete. A high range water reducer also ensures good workability. The combination of all these elements enables drying times to be as low as three to four weeks.

When concrete is used in applications such as slabs and floors, it needs to fulfil specific performance criteria, such as a slump value of 10 to 15 cm, a relative low plastic viscosity to facilitate its placing, and enough bleeding water, i.e. a film of water that forms at the surface of concrete after having been placed. This film of water ensures easy finishing of the fresh concrete surface, and provides self-curing protection that prevents the formation of cracks.

The concrete compositions described in US2011/0015306 and US2012/097072 are characterised by a lower water cement ratio than conventional flooring concretes, and contain fine reactive materials. These two specificities both have a negative impact on fresh concrete rheology: fresh concrete tends to be sticky, risks having a reduced workability retention time, and bleeding water may be suppressed. It is a purpose of this invention to develop a concrete composition with reduced drying times that also has a lower viscosity, good workability retention, and with which sufficient bleeding water is always achieved.

To solve these and other objectives, the invention is characterized in that the hydraulic binder comprises a Portland cement of high reactivity and the hydraulic binder is present in an amount of 280-340 kg per cubic meter of concrete, that a shrinkage reducing admixture is present in an amount of 0-4 L per cubic meter of concrete and that water is present in an amount of 140-160 L per cubic meter of concrete.

It was found that the concrete of the invention has the following advantages: when fresh, the rheology is similar to conventional concrete for flooring applications (reduced viscosity, slump and slump retention over time). Further, 5 the setting time and strength development are similar to conventional concrete. In addition, once hardened, the drying times are significantly reduced.

In particular, it was found that using a Portland cement 10 having a high reactivity contributes to the above advantages of the invention. Preferably, a Portland cement is considered having a high reactivity, if, either when used alone or in combination with other hydraulic binders, it provides a compressive strength at 28 days of at least 15 52,5 MPa and/or a compressive strength at 1 day of at least 20 MPa according to European Standards EN 196-2.

In particular, the reactivity of the hydraulic binder is selected such as to obtain a 28-days compressive strength 20 of the concrete of $> 52,5$ MPa according to European Standards EN 196-2.

In particular, the reactivity of the hydraulic binder is selected such as to obtain a 1-day compressive strength of 25 the concrete of > 20 MPa according to European Standards EN 196-2.

A high reactivity of the Portland cement may preferably be achieved if the Portland cement has a Blaine fineness of 30 $4500-6500$ cm^2/g .

According to a preferred embodiment of the invention the hydraulic binder comprises ordinary Portland cement and a

supplementary cementitious material, such as granulated blast furnace slag, fly ash, pozzolans or mixtures thereof. The supplementary cementitious material is preferably present in an amount of 1-20 wt.-% of the hydraulic binder.

5 In order to achieve sufficient reactivity, the supplementary cementitious material may preferably have a Blaine fineness of 4500-6500 cm²/g.

According to the invention the concrete composition may
10 contain a shrinkage reducing admixture in an amount of 0-4 L per cubic meter of concrete. In this connection, it was surprisingly found that the use of a shrinkage reducing admixture at lower binder amounts per cubic metre of concrete significantly lowers the drying time of concrete,
15 whereas at higher binder contents, it tends to slow the drying of concrete. When used in specific conditions, the shrinkage reducing admixture accelerates the drying of hardened concrete.

20 In light of the above, a preferred embodiment of the invention provides for the shrinkage reducing admixture being present in an amount of 3-4 L per cubic meter of concrete and the hydraulic binder being present in an amount of 280-310 kg per cubic meter of concrete. Thus, a
25 relatively high amount of shrinkage reducing admixture is used to reduce the drying time of concrete at lower binder amounts per cubic metre of concrete. In contrast, in another preferred embodiment of the invention, no or a little amount of shrinkage reducing admixture is used at
30 higher binder amounts per cubic metre of concrete. In particular, the shrinkage reducing admixture may be present in an amount of 0-1 L per cubic meter of concrete and the

hydraulic binder may be present in an amount of 310-340 kg per cubic meter of concrete.

In the context of the invention, conventional liquid shrinkage reducing admixtures may be used. Chemical shrinkage reducing admixtures are commonly used to mitigate drying shrinkage of concrete. They are in most cases a liquid mixture of surfactants and glycols. Their mechanism of action relies on the reduction of the surface tension and capillary forces upon free water evaporation in the pores of less than 50 nm diameter. These chemical admixtures do not cause the concrete to expand, nor prevent it from shrinking: their main purpose is to reduce the extent of shrinkage.

Preferably, the shrinkage reducing admixture is an organic admixture, in particular based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants.

In order to improve the workability of the concrete mass, the mixture may preferably comprise a water reducing agent, in particular a polycarboxylate ether based or a polynaphthalene sulfonate based plasticizing admixture, the water reducing agent preferably being present in an amount of between 0,4 and 1,5 wt.-% of the hydraulic binder.

Plasticizing admixtures are sometimes also referred to as dispersing agents or flow agents and are deployed in order to improve workability with regard to flowability. Such admixtures are long chained organic molecules, that group around the cement particles and thus either bring about electrostatic repulsion between the particles or steric

stabilisation of the particles, thereby increasing flowability of the building material.

According to a preferred embodiment of the invention, the concrete composition further comprises an expanding agent, such as CaO, preferably in an amount of 0,5-3 wt.-% of the hydraulic binder. Calcium oxide is a known expanding agent that is able to compensate the natural drying shrinkage that concrete undergoes during its service life. This reduces the formation of cracks resulting from plastic shrinkage of the concrete mass, which in turn increases the water tightness of concrete structures. It was found that the addition of calcium oxide at a dosage of up to 3,0 wt.-% does not have a significant impact on concrete drying times.

The concrete composition of the invention, in particular by adjusting the amount of water and hydraulic binder, allows to achieve a flow of the freshly mixed concrete at 10 min of at least 100 mm +/- 10 mm.

In a particularly preferred embodiment, the concrete, within less than 30-50 days, in particular less than 30-40 days, after placing has a relative humidity of 80% according to ASTM F2170.

The invention will now be described with reference to the following exemplary embodiments.

Concrete was mixed according to several designs as described in Table 1. The aggregates used in all concrete compositions were identical and followed a 0-16 Fuller size gradation. All concretes contain 150 L of water per cubic

metre. The dosage of the admixture was adjusted to reach a concrete slump at 10 minutes of 100 mm +/- 10 mm. Mortar of concrete is sieved and concrete slabs of 30 by 90 cm size and 15 cm thickness were casted and cured in room at 20°C and 65% relative humidity. The mortar is placed in a bowl and let to sit 45 minutes. The bowl is then gently tilted and the water that appeared is collected and weighed. Bleeding is then expressed as a percentage of total water in the concrete composition. The relative humidity is measured as function of time following the procedure described in ASTM F2170, and Table 2 reports the time in days required to reach 80% relative humidity.

Table 1:

Mix #	Total binder (kg/m ³)	Slag content (wt-%)	Water reducer (wt-%)	Shrinkage reducing agent (L/m ³)	CaO (wt-%)
1	280	15	0.5	0	0
2	280	15	0.7	0	3
3	340	15	0.5	4	0
4	340	15	0.6	4	3
5	280	15	0.5	4	0
6	280	15	0.7	4	3
7	340	15	0.5	0	0
8	340	15	0.7	0	3

The results displayed in Table 2 show that under the described laboratory conditions, the reference concrete (mix #1) requires 100 days to dry to an internal relative humidity of 80%. Adding 3% calcium oxide does not have a significant impact on drying times. Comparing lines 1 and 2 to lines 7 and 8 shows that increasing the binder content decreases significantly the drying times. Interestingly, line 6 shows that the same shorter drying times can be

achieved with leaner concrete that contains 4 L/m³ of shrinkage reducing agent. On the contrary, comparing lines 3 and 4 to lines 7 and 8 shows that adding the shrinkage reducing agent to a concrete containing more binder per cubic metre increases the drying times, that means the contrary effect to that observed at 280 kg of binder per cubic metre.

In all systems, bleeding water is collected, and remains highest in the reference concrete (mix #1). Even the concrete compositions that give the lowest drying times have acceptable bleeding water amounts.

Table 2:

Mix #	Time to reach 80% relative humidity (days)	Bleeding at 45 minutes (wt-%)
1	100	4.6
2	105	3.2
3	69	3.2
4	75	2.2
5	39	4.5
6	47	3.8
7	40	3.1
8	39	2.4

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To sum up, the invention describes concrete compositions that combine several opposing physical properties: reduced drying times, but good fresh concrete workability and capacity to generate bleeding water at the concrete surface once placed. Further, the concrete compositions of this invention exhibit no stickiness. It was found that the use of shrinkage reducing admixtures, in specific conditions of

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water and binder amounts per cubic metre of concrete, act as an accelerator for concrete drying.

Claims:

1. Concrete composition comprising, in a mixture with water, a hydraulic binder, sand and aggregates,
5 characterized in that the hydraulic binder comprises a Portland cement of high reactivity and the hydraulic binder is present in an amount of 280-340 kg per cubic meter of concrete, that a shrinkage reducing admixture is present in an amount of 0-4 L per cubic meter of concrete and that
10 water is present in an amount of 140-160 l per cubic meter of concrete.
2. Concrete composition according to claim 1, wherein the reactivity of the hydraulic binder is selected such as to
15 obtain a 28d compressive strength of the concrete of > 52,5 MPa.
3. Concrete composition according to claim 1 or 2, wherein the reactivity of the hydraulic binder is selected
20 such as to obtain a 1d compressive strength of the concrete of > 20 MPa.
4. Concrete composition according to claim 1, 2 or 3, wherein the shrinkage reducing admixture is present in an
25 amount of 3-4 L per cubic meter of concrete and the hydraulic binder is present in an amount of 280-310 kg per cubic meter of concrete.
5. Concrete composition according to any one of claims 1
30 to 4, wherein the shrinkage reducing admixture is present in an amount of 0-1 L per cubic meter of concrete and the hydraulic binder is present in an amount of 310-340 kg per cubic meter of concrete.

6. Concrete composition according to any one of claims 1 to 5, wherein the shrinkage reducing admixture is an organic admixture, in particular based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants.

7. Concrete composition according to any one of claims 1 to 6, wherein the hydraulic binder comprises a supplementary cementitious material, preferably ground granulated blast furnace slag, fly ash, pozzolans, ground limestone or mixtures thereof.

8. Concrete composition according to claim 7, wherein the supplementary cementitious material is present in an amount of 1-20 wt.-% of the hydraulic binder.

9. Concrete composition according to any one of claims 1 to 8, wherein the Portland cement has a Blaine fineness of 4500-6500 cm²/g.

10. Concrete composition according to any one of claims 7 to 9, wherein the supplementary cementitious material has a Blaine fineness of 4500-6500 cm²/g.

11. Concrete composition according to any one of claims 1 to 10, further comprising an expanding agent, such as CaO, preferably in an amount of 0,5-3 wt.-% of the hydraulic binder.

12. Concrete composition according to any one of claims 1 to 11, further comprising a water reducing agent, which is

preferably present in an amount between 0,4 and 1 wt.-% of the hydraulic binder.

13. Concrete composition according to claim 12, wherein
5 the water reducing agent comprises poly-carboxylate ether or polynaphthalene sulfonate.

14. Concrete composition according to any one of claims 1
to 13, wherein the amount of water and hydraulic binder is
10 selected so as to reach a flow of the freshly mixed concrete at 10 min of at least 100 mm +/- 10 mm.

15. Concrete composition according to any one of claims 1
to 14, wherein the concrete, within less than 30-50 days,
15 in particular less than 30-40 days, after placing has a relative humidity of 80% according to ASTM F2170.

16. A hydraulic binder for producing a concrete mix
composition according to any one of claims 1 to 15.

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17. A construction element comprising concrete or made of concrete produced using a concrete mix composition according to any one of claims 1 to 15.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/000665

A. CLASSIFICATION OF SUBJECT MATTER

INV. C04B28/04
ADD. C04B111/60 C04B111/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/000665

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International application No
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International application No

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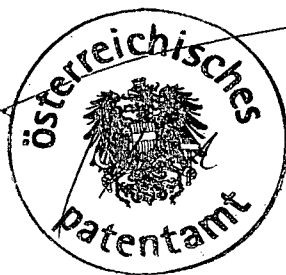
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Aktenzeichen: A 329/2015

Das Österreichische Patentamt bestätigt, dass die Firma
Holcim Technology Ltd, Zürcherstrasse 156, 8645 Rapperswil-Jona, SCHWEIZ,
am 26.05.2015 eine Patentanmeldung betreffend
„Betonzusammensetzung“,
überreicht hat und dass die beigeheftete Beschreibung mit der ursprünglich, zugleich mit
dieser Patentanmeldung überreichten Beschreibung übereinstimmt.

Österreichisches Patentamt
Wien, 17.05.2016

Die Präsidentin:
i.A. FOINSP Gabriela Theil



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AT PATENTSCHRIFT

(11)Nr.

(Bei der Anmeldung sind nur die eingerahmten Felder auszufüllen)

(73)	Patentanmelder/in (bzw. -inhaber/in)
	Holcim Technology Ltd Rapperswil-Jona, SCHWEIZ
(54)	Titel der Anmeldung
	Betonzusammensetzung
(61)	Zusatz zu Patent Nr.
(66)	Umwandlung von
(62)	Gesonderte Anmeldung aus (Teilung)
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The invention refers to a concrete composition comprising in a mixture with water, a hydraulic binder, sand, aggregates, with reduced drying time once hardened.

Further, the invention refers to a hydraulic binder composition for producing a concrete with reduced drying time, while being able to provide a good amount of bleeding water, excellent fresh concrete behaviour, and comprising ordinary Portland cement, optionally a supplementary cementitious material and an expanding agent.

Concrete is a very widely used construction material with high strength and good durability. In addition to aggregates and water, it also contains Portland cement as a hydraulic binder, which produces strength-forming phases by reacting and solidifying in contact with water. Concrete based on Portland cement clinker is thus one of the most important construction materials worldwide.

When Portland cement formulations are mixed with water, hydration reactions immediately begin to form minerals. These reactions generate heat and form a dense microstructure of cement hydrates that gives concrete its final strength and durability properties. The water added to a concrete composition is also a chemical reactant that first acts by dissolving the mineral constituents of Portland cement. As these minerals dissolve, the concentration of mainly calcium, hydroxide, silicate, aluminate, and sulphate ions increase in the water of the fresh concrete composition. When the concentration has reached a sufficiently high level, a point of supersaturation, the ions precipitate in the form of mineral hydrates, such as ettringite, or CSH gel. These hydrates

contain large amounts of water trapped in their respective mineral structures.

A cubic metre of concrete typically contains between 140 and 200 L of water, and between 280 and 450 kg of hydraulic binder. In most concrete compositions, the total amount of water exceeds the stoichiometry of the hydration reactions of Portland cement, which means that even after its final setting time, large amounts of free water remain in the concrete structure. This water fills capillary pores within the concrete mass, and gradually evaporates over time.

When concrete is used for interior floors, in many cases the hardened concrete surface is afterwards covered by protective or decorative layers such as paint, sealants, carpet, or wood. This additional layer forms a barrier to water migration and in case of large amounts of free water still within the concrete structure, the protective or decorative layers suffer chemical and physical changes upon water migration. The final results are uneven changes of the colour of the coating, reduction of its adherence to the underlying concrete surface, or swelling of wooden floorings. In all these situations, the concrete coating fails, and needs to be replaced. The costs and delays associated are potentially a major issue for the construction industry. To prevent this, the relative humidity within a concrete mass is measured according to the procedures described in the ASTM standards F2170 and F2420, and concrete floors should be covered once their relative humidity decreases to below a threshold value of 80%. In practice, the drying of concrete floors is slow: it can typically require 6 to 8 weeks for the relative

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humidity to reach 80%. It is a purpose of this invention to reduce these drying times.

US 2011/0015306 and US 2012/097072 disclose concrete compositions with reduced drying times. The concretes described are characterised by a relatively low water cement ratio of between 0,2 and 0,4, the addition of fine cementitious materials of high reactivity, the use of a standard shrinkage reducing admixture, and the use of a vapour attenuation agent selected from alkali metal halide salts, alkali metal nitrate salts and alkali metal nitride salts. The water cement ratio is kept as low as possible to ensure that the amount of free water in the concrete slab is kept low. The fine cementitious materials of increased reactivity increase the formation of hydrates during the early stages of the hardening reactions; increasing in turn the ratio between water trapped in mineral hydrates and free water in the pore solutions. The preferred fine materials are fine calcium carbonates or fine silica fume. Accelerators such as sodium nitrite or calcium silicate are used for the same purpose, as they increase the formation of hydrates. A standard shrinkage reducing agent such as polypropylene glycol is said to favour the formation of a denser network of smaller capillary pores in the concrete structure, facilitation the migration of free water to the surface of concrete where it evaporates. In the case of lightweight concrete slabs, synthetic polymer particles are preferred to lightweight aggregates since these later products considerably slow the drying of concrete. A high range water reducer also ensures good workability. The combination of all these elements enables drying times to be as low as three to four weeks.

When concrete is used in applications such as slabs and floors, it needs to fulfil specific performance criteria, such as a slump value of 10 to 15 cm, a relative low plastic viscosity to facilitate its placing, and enough bleeding water, i.e. a film of water that forms at the surface of concrete after having been placed. This film of water ensures easy finishing of the fresh concrete surface, and provides self-curing protection that prevents the formation of cracks.

The concrete compositions described in US2011/0015306 and US2012/097072 are characterised by a lower water cement ratio than conventional flooring concretes, and contain fine reactive materials. These two specificities both have a negative impact on fresh concrete rheology: fresh concrete tends to be sticky, risks having a reduced workability retention time, and bleeding water may be suppressed. It is a purpose of this invention to develop a concrete composition with reduced drying times that also has a lower viscosity, good workability retention, and with which sufficient bleeding water is always achieved.

To solve these and other objectives, the invention is characterized in that the hydraulic binder comprises a Portland cement of high reactivity and the hydraulic binder is present in an amount of 280-340 kg per cubic meter of concrete, that a shrinkage reducing admixture is present in an amount of 0-4 L per cubic meter of concrete and that water is present in an amount of 140-160 L per cubic meter of concrete.

It was found that the concrete of the invention has the following advantages: when fresh, the rheology is similar

to conventional concrete for flooring applications (reduced viscosity, slump and slump retention over time). Further, the setting time and strength development are similar to conventional concrete. In addition, once hardened, the drying times are significantly reduced.

In particular, it was found that using a Portland cement having a high reactivity contributes to the above advantages of the invention. Preferably, a Portland cement is considered having a high reactivity, if, either when used alone or in combination with other hydraulic binders, it provides a compressive strength at 28 days of at least 52,5 MPa and/or a compressive strength at 1 day of at least 20 MPa according to European Standards EN 196-2.

In particular, the reactivity of the hydraulic binder is selected such as to obtain a 28-days compressive strength of the concrete of $> 52,5$ MPa according to European Standards EN 196-2.

In particular, the reactivity of the hydraulic binder is selected such as to obtain a 1-day compressive strength of the concrete of > 20 MPa according to European Standards EN 196-2.

A high reactivity of the Portland cement may preferably be achieved if the Portland cement has a Blaine fineness of 4500-6500 cm^2/g .

According to a preferred embodiment of the invention the hydraulic binder comprises ordinary Portland cement and a supplementary cementitious material, such as granulated blast furnace slag, fly ash, pozzolans or mixtures thereof.

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The supplementary cementitious material is preferably present in an amount of 1-20 wt.-% of the hydraulic binder. In order to achieve sufficient reactivity, the supplementary cementitious material may preferably have a Blaine fineness of 4500-6500 cm²/g.

According to the invention the concrete composition may contain a shrinkage reducing admixture in an amount of 0-4 L per cubic meter of concrete. In this connection, it was surprisingly found that the use of a shrinkage reducing admixture at lower binder amounts per cubic metre of concrete significantly lowers the drying time of concrete, whereas at higher binder contents, it tends to slow the drying of concrete. When used in specific conditions, the shrinkage reducing admixture accelerates the drying of hardened concrete.

In light of the above, a preferred embodiment of the invention provides for the shrinkage reducing admixture being present in an amount of 3-4 L per cubic meter of concrete and the hydraulic binder being present in an amount of 280-310 kg per cubic meter of concrete. Thus, a relatively high amount of shrinkage reducing admixture is used to reduce the drying time of concrete at lower binder amounts per cubic metre of concrete. In contrast, in another preferred embodiment of the invention, no or a little amount of shrinkage reducing admixture is used at higher binder amounts per cubic metre of concrete. In particular, the shrinkage reducing admixture may be present in an amount of 0-1 L per cubic meter of concrete and the hydraulic binder may be present in an amount of 310-340 kg per cubic meter of concrete.

In the context of the invention, conventional liquid shrinkage reducing admixtures may be used. Chemical shrinkage reducing admixtures are commonly used to mitigate drying shrinkage of concrete. They are in most cases a liquid mixture of surfactants and glycols. Their mechanism of action relies on the reduction of the surface tension and capillary forces upon free water evaporation in the pores of less than 50 nm diameter. These chemical admixtures do not cause the concrete to expand, nor prevent it from shrinking: their main purpose is to reduce the extent of shrinkage.

Preferably, the shrinkage reducing admixture is an organic admixture, in particular based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants.

In order to improve the workability of the concrete mass, the mixture may preferably comprise a water reducing agent, in particular a polycarboxylate ether based or a polynaphthalene sulfonate based plasticizing admixture, the water reducing agent preferably being present in an amount of between 0,4 and 1,5 wt.-% of the hydraulic binder.

Plasticizing admixtures are sometimes also referred to as dispersing agents or flow agents and are deployed in order to improve workability with regard to flowability. Such admixtures are long chained organic molecules, that group around the cement particles and thus either bring about electrostatic repulsion between the particles or steric stabilisation of the particles, thereby increasing flowability of the building material.

According to a preferred embodiment of the invention, the concrete composition further comprises an expanding agent, such as CaO , preferably in an amount of 0,5-3 wt.-% of the hydraulic binder. Calcium oxide is a known expanding agent that is able to compensate the natural drying shrinkage that concrete undergoes during its service life. This reduces the formation of cracks resulting from plastic shrinkage of the concrete mass, which in turn increases the water tightness of concrete structures. It was found that the addition of calcium oxide at a dosage of up to 3,0 wt.-% does not have a significant impact on concrete drying times.

The concrete composition of the invention, in particular by adjusting the amount of water and hydraulic binder, allows to achieve a flow of the freshly mixed concrete at 10 min of at least 100 mm +/- 10 mm.

In a particularly preferred embodiment, the concrete, within less than 30-50 days, in particular less than 30-40 days, after placing has a relative humidity of 80% according to ASTM F2170.

The invention will now be described with reference to the following exemplary embodiments.

Concrete was mixed according to several designs as described in Table 1. The aggregates used in all concrete compositions were identical and followed a 0-16 Fuller size gradation. All concretes contain 150 L of water per cubic metre. The dosage of the admixture was adjusted to reach a

concrete slump at 10 minutes of 100 mm +/- 10 mm. Mortar of concrete is sieved and concrete slabs of 30 by 90 cm size and 15 cm thickness were casted and cured in room at 20°C and 65% relative humidity. The mortar is placed in a bowl and let to sit 45 minutes. The bowl is then gently tilted and the water that appeared is collected and weighed. Bleeding is then expressed as a percentage of total water in the concrete composition. The relative humidity is measured as function of time following the procedure described in ASTM F2170, and Table 2 reports the time in days required to reach 80% relative humidity.

Table 1:

Mix #	Total binder (kg/m ³)	Slag content (wt-%)	Water reducer (wt-%)	Shrinkage reducing agent (L/m ³)	CaO (wt-%)
1	280	15	0.5	0	0
2	280	15	0.7	0	3
3	340	15	0.5	4	0
4	340	15	0.6	4	3
5	280	15	0.5	4	0
6	280	15	0.7	4	3
7	340	15	0.5	0	0
8	340	15	0.7	0	3

The results displayed in Table 2 show that under the described laboratory conditions, the reference concrete (mix #1) requires 100 days to dry to an internal relative humidity of 80%. Adding 3% calcium oxide does not have a significant impact on drying times. Comparing lines 1 and 2 to lines 7 and 8 shows that increasing the binder content decreases significantly the drying times. Interestingly, line 6 shows that the same shorter drying times can be achieved with leaner concrete that contains 4 L/m³ of

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shrinkage reducing agent. On the contrary, comparing lines 3 and 4 to lines 7 and 8 shows that adding the shrinkage reducing agent to a concrete containing more binder per cubic metre increases the drying times, that means the contrary effect to that observed at 280 kg of binder per cubic metre.

In all systems, bleeding water is collected, and remains highest in the reference concrete (mix #1). Even the concrete compositions that give the lowest drying times have acceptable bleeding water amounts.

Table 2:

Mix #	Time to reach 80% relative humidity (days)	Bleeding at 45 minutes (wt-%)
1	100	4.6
2	105	3.2
3	69	3.2
4	75	2.2
5	39	4.5
6	47	3.8
7	40	3.1
8	39	2.4

To sum up, the invention describes concrete compositions that combine several opposing physical properties: reduced drying times, but good fresh concrete workability and capacity to generate bleeding water at the concrete surface once placed. Further, the concrete compositions of this invention exhibit no stickiness. It was found that the use of shrinkage reducing admixtures, in specific conditions of water and binder amounts per cubic metre of concrete, act as an accelerator for concrete drying.

Claims:

1. Concrete composition comprising, in a mixture with water, a hydraulic binder, sand and aggregates, characterized in that the hydraulic binder comprises a Portland cement of high reactivity and the hydraulic binder is present in an amount of 280-340 kg per cubic meter of concrete, that a shrinkage reducing admixture is present in an amount of 0-4 L per cubic meter of concrete and that water is present in an amount of 140-160 l per cubic meter of concrete.
2. Concrete composition according to claim 1, wherein the reactivity of the hydraulic binder is selected such as to obtain a 28d compressive strength of the concrete of > 52,5 MPa.
3. Concrete composition according to claim 1 or 2, wherein the reactivity of the hydraulic binder is selected such as to obtain a 1d compressive strength of the concrete of > 20 MPa.
4. Concrete composition according to claim 1, 2 or 3, wherein the shrinkage reducing admixture is present in an amount of 3-4 L per cubic meter of concrete and the hydraulic binder is present in an amount of 280-310 kg per cubic meter of concrete.
5. Concrete composition according to any one of claims 1 to 4, wherein the shrinkage reducing admixture is present in an amount of 0-1 L per cubic meter of concrete and the hydraulic binder is present in an amount of 310-340 kg per cubic meter of concrete.

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6. Concrete composition according to any one of claims 1 to 5, wherein the shrinkage reducing admixture is an organic admixture, in particular based on polypropylene glycol, polyethylene glycol and/or a glycol ether derivative, preferably in a liquid mixture with surfactants.

7. Concrete composition according to any one of claims 1 to 6, wherein the hydraulic binder comprises a supplementary cementitious material, preferably ground granulated blast furnace slag, fly ash, pozzolans, ground limestone or mixtures thereof.

8. Concrete composition according to claim 7, wherein the supplementary cementitious material is present in an amount of 1-20 wt.-% of the hydraulic binder.

9. Concrete composition according to any one of claims 1 to 8, wherein the Portland cement has a Blaine fineness of 4500-6500 cm^2/g .

10. Concrete composition according to any one of claims 7 to 9, wherein the supplementary cementitious material has a Blaine fineness of 4500-6500 cm^2/g .

11. Concrete composition according to any one of claims 1 to 10, further comprising an expanding agent, such as CaO , preferably in an amount of 0,5-3 wt.-% of the hydraulic binder.

12. Concrete composition according to any one of claims 1 to 11, further comprising a water reducing agent, which is

preferably present in an amount between 0,4 and 1 wt.-% of the hydraulic binder.

13. Concrete composition according to claim 12, wherein the water reducing agent comprises poly-carboxylate ether or polynaphthalene sulfonate.

14. Concrete composition according to any one of claims 1 to 13, wherein the amount of water and hydraulic binder is selected so as to reach a flow of the freshly mixed concrete at 10 min of at least 100 mm +/- 10 mm.

15. Concrete composition according to any one of claims 1 to 14, wherein the concrete, within less than 30-50 days, in particular less than 30-40 days, after placing has a relative humidity of 80% according to ASTM F2170.

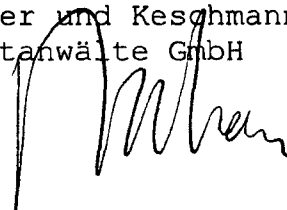
16. A hydraulic binder for producing a concrete mix composition according to any one of claims 1 to 15.

17. A construction element comprising concrete or made of concrete produced using a concrete mix composition according to any one of claims 1 to 15.

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Abstract:

Concrete composition comprising, in a mixture with water, a hydraulic binder, sand and aggregates, characterized in that the hydraulic binder comprises a Portland cement of high reactivity and the hydraulic binder is present in an amount of 280-340 kg per cubic meter of concrete, that a shrinkage reducing admixture is present in an amount of 0-4 L per cubic meter of concrete and that water is present in an amount of 140-160 L per cubic meter of concrete.

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