EAD **150059-00-0301**

www.eota.eu

July 2021

European Assessment Document for

Natural binder made from “Scaglia Rossa” marl for construction mixtures

The reference title and language for this EAD is English. The applicable rules of copyright refer to the document elaborated in and published by EOTA.

This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers the assessment of a natural hydraulic binder which, when mixed with water, forms a paste that hardens by means of hydration reactions such as mortars and concretes.

The binder, hereinafter „*Natural Binder* “, is produced from a marl composed of variable fraction of $CaCO_3$ and a natural balanced proportion of clays, which has the specific geological name: “Scaglia Rossa”. The ratio of these components depends on the genesis of the deposits, influenced by various pH levels and temperatures, which either promote or hinder mixed associations. The genesis of these rocks is, therefore, complex, explaining their continuous variability. However, the industrial use of these rocks is determined by the average titration of the cultivated bench, rather than individual portions. The characteristics of the deposit make it necessary to cultivate in simultaneous benches to ensure the greatest possible homogeneity of the material. Collected data show that the $CaCO_3$ content is generally over 70% throughout the deposit, making it optimal for the production of both lime and cement.

In analogy with Portland cement clinker, the „*Natural Binder*“ is obtained by heating of a raw material containing elements, usually expressed as oxides, CaO, SiO_2, Al_2O_3, Fe_2O_3 and small quantities of other materials. The result of this process is a hydraulic compound characterised by a ratio by mass (CaO)/(SiO_2) that shall be not less than 2,0 and a content of magnesium oxide (MgO) that shall not exceed 5,0 % by mass.

The stability of the raw material’s elemental composition and the control of the productive process ensure the product’s claimed performance - see table 3.2.1.

The “Natural Binder” is not fully covered by a harmonized European standard EN 459-1[1] due to the fact that the “available lime”, as available wCa(OH)$_2$, shall be less than 15% and the standard does not cover the following characteristics, which are applicable for the binder covered by this EAD:

- Compressive strength after 56 days,
- Content of C_3A, content of C_3S and other Silicate and Aluminate,
- Modulus of elasticity in compression,
- Water vapour absorption,
- Water absorption coefficient and drying rate,
- Content of soluble salts,
- Resistance to pollutant agents,
- Heat of hydration,
- The following dangerous substances: natural radioactivity, VOC emission, polycyclic aromatic hydrocarbons and heavy metals.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise their clients on the transport, storage, maintenance, replacement and repair of the product, as the manufacturer considers necessary.

It is assumed that the product will be installed according to the manufacturer’s instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer’s stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

---

[1] All undated references to standards in this EAD are to be understood as references to the dated versions listed in clause 4.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The “Natural Binder” is intended to be used to produce mortars, grouts, concretes and other mixes for construction and for the manufacture of construction products, including cast-in-situ and prefabricated structural concrete in accordance the EN 206, with exposure class X0 (different exposure classes may be determined with the "equivalent concrete performance" concept in accordance with EN 206).

The product can be used for structural and non-structural uses.

Examples of use of the product as a binder in structural concrete, according to EN 206, in historical restoration are:

- consolidation of wooden slabs with reinforced concrete,
- consolidation of foundations (building of concrete layers under the existing foundation and connection),
- construction of summit curbs to reinforce top walls and under roof masonry support,
- inserting of concrete walls within existing masonry walls as reinforcement or replacement of existing walls support of slabs or for handling possible seismic events,
- filling of voids within walls layers with structural purposes,
- renovation of historical concrete (such as roman concrete) for walls, slabs, roofs and foundations.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer’s request to take into account a working life of the “Natural Binder” for the intended use of 50 years when installed in the works. These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD

1.3.1 Specific terms

Modulus of elasticity in compression

- **Compressive stress**: Compressive force carried at any time by the test specimen per unit of the original cross-section.
- **Compressive strain**: Ratio of the change in the distance between two reference points along the axis of the test specimen per unit length of the original distance.
- **Creep**: Additional time-dependent strain that occurs in a test specimen under a constant applied stress.
- **Secant modulus**: Ratio of stress to a corresponding strain, measured relative to a level of pre-stress applied to firmly bed the specimen, platens, and ball seating.

Water vapour absorption

- **Moisture buffer value** (MBV): procedure refers to the moisture uptake/release when the material is exposed to a square wave in relative humidity between 75 % RH (relative humidity) during 8

---

[2] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the assumed working life.

hours and 33 % RH during 16 hours. The value is normalized per exposed surface area and change in RH.

Content of soluble salts

- **Soluble salts**: salts that dissolve easily in a solvent such as water to form a solution; solubility depends on salt and water temperature.
- **Conductivity***:* measure of the ability of water to conduct electricity; it depends on the quantity (portion) of solids (as salts) dissolved (dissolvable) in the water.
- **Specific conductivity***:* conductivity of a solution measured between two electrodes with an area of 1 cm^2 and 1 cm apart.

1.3.2 Symbols

Available lime		
Available wCa(OH)$_2$	[%$_w$]	Content of available lime
Compressive strength		
$R_{C,7}$	[MPa]	Mean value of compressive strength of the 2 specimens (7 days)
$R_{C,28}$	[MPa]	Mean value of compressive strength of the 2 specimens (28 days)
$R_{C,56}$	[MPa]	Mean value of compressive strength of the 2 specimens (56 days)
Setting time		
T_{Si}	[min]	Initial setting time
T_{Sf}	[min]	Final setting time
Particle Size		
R_{63}	[%]	Mass retained on each sieve (0,063 mm)
R_{125}	[%]	Mass retained on each sieve (0,125 mm)
Modulus of elasticity in compression		
σ_2	[MPa]	Minimum stress for elastic modulus measurement
σ_1	[MPa]	Maximum stress for elastic modulus measurement
σ_c	[MPa]	Compressive strength of the specimen
σ_f	[MPa]	Failure stress after the elastic modulus measurement
ε_i	[mm]	Strain measured after pre-load of the specimen
ε_f	[mm]	Strain measured after complete load of the specimen
$\Delta\varepsilon$	[mm]	Difference of strain in the elastic modulus measurement
$\Delta\sigma$	[MPa]	Difference of stress in the elastic modulus measurement
$E_{M,C}$	[GPa]	Mean secant modulus
Water vapour absorption		
m_0	[g]	Mass of the specimens at the beginning of the high RH conditioning
m_{8h}	[g]	Mass of the specimens after the high RH conditioning
m_{24h}	[g]	Mass of the specimens at the end of the high RH conditioning
Δm	[g]	Difference between the mass gain and loss during conditioning
A_N	[m^2]	Surface of the specimen exposed to conditioning
ΔRH	[%]	Difference between high RH and low RH
MBV	[g/m^2%$_{RH}$]	Moisture Buffer Value, it measures the % of moisture absorbed from a material
Water absorption and drying rate		
$M_{0,i}$	[g]	Dry mass of the specimen
$M_{1,i}$	[g]	Mass of the specimen after 10 min of immersion
$M_{2,i}$	[g]	Mass of the specimen after 90 min of immersion
$M_{3,i}$	[g]	Mass of the specimen after 24 h of immersion
$C_{90,i}$	[kg/(m^{2}min$^{0.5}$]	Water absorption coefficient (single value) evaluated after 90 min
$C_{24h,i}$	[kg/m^2]	Water absorption coefficient (single value) evaluated after 24 hours
$h_{24h,i}$	[mm]	Depth of water penetration (single value)
$C_{90,m}$	[kg/(m^{2}min$^{0.5}$]	Water absorption coefficient (mean value) evaluated after 90 min
$C_{24h,m}$	[kg/m^2]	Water absorption coefficient (mean value) evaluated after 24 hours
$h_{24h,m}$	[mm]	Depth of water penetration after 24 h (mean value)
$M_{D,i}$	[g]	Dry mass of the specimen
$M_{W,i}$	[g]	Mass of the specimen after 7 days of immersion
$M_{D,m}$	[g]	Dry mass of the specimens (mean value)
$M_{W,m}$	[g]	Mass of the specimens after 7 days of immersion (mean value)
$M_{E,i}$	[g]	Mass of the specimen in a situation of thermo-hygrometric equilibrium
$M_{A,i}$	[g]	Mass of water absorbed by each specimen placed in immersion
$M_{E,m}$	[g]	Mass of the specimen in a situation of thermo-hygrometric equilibrium (mean v.)
$M_{A,m}$	[g]	Mass of water absorbed by each specimen placed in immersion (mean value)
$W_{E,i}$	[%]	Percentage of water/moisture absorbed by the specimens in a situation of thermo-hygrometric equilibrium
$t_{10,i}$	[min]	Time for the drying of the 10% of the specimen
$t_{90,i}$	[min]	Time for the drying of the 90% of the specimen
$t_{10,m}$	[min]	Mean time for the drying of the 10% of the specimens
$t_{90,m}$	[min]	Mean time for the drying of the 90% of the specimens

$M_{10,i}$	[g]	Mass of the specimen at the 10% of drying
$M_{90,i}$	[g]	Mass of the specimen at the 90% of drying
$M_{10,m}$	[g]	Mass of the specimens at the 10% of drying (mean value)
$M_{90,m}$	[g]	Mass of the specimens at the 90% of drying (mean value)
$W_{E,m}$	[%]	Average percentage of water/moisture absorbed by the specimens in a situation of thermo-hygrometric equilibrium
$W_{A,m}$	[%]	Average percentage of water absorbed by the specimens
D_R	[g/h]	Average drying rate

Soundness

Sdn	[mm]	Soundness

Sulphate (expressed as SO_3)

wSO_3	[$\%_w$]	Sulphate content, expressed as SO_3 content

Content of C_3A, C_3S and other silicates and aluminates

$\%C_3A$	[%]	C_3A content (Tricalcium Aluminates - $3CaO.Al_2O_3$ – Celite)
$\%C_3S$	[%]	C_3S content (Tricalcium Silicates - $3CaO.SiO_2$ - Alite)
$\%C_2S$	[%]	C_2S content (Bicalcium Silicates - $2CaO.SiO_2$ – Belite)
$\%CS$	[%]	CS content (Calcium Silicates - $CaO.SiO_2$ - Wollastonite)
$\%C_4AF$	[%]	C_4AF content (Tetracalcic Aluminate Ferrite - $4CaO.Al_2O_3.Fe_2O_3$ – Brownmillerite)

Resistance to pollutant agents

$M_{d,i}$	[g]	Initial dry mass of the specimen
$M_{S28,i}$	[g]	Dry mass of the specimen after 28 exposition's days (to sulphate)
$R_{S28,i}$	[MPa]	Compression resistance of the specimen after 28 exposition's days (to sulphate)
$R_{Sr,i}$	[MPa]	Final compression resistance of the reference
$R_{Sr,m}$	[MPa]	Final compression resistance of the reference (mean value)
$\Delta M_{S,i}$	[g]	Relative mass difference after 28 exposition's days (to sulphate)
$\Delta R_{cS,i}$	[%]	Relative compression resistance difference after 28 exposition's days (to sulphate)
$\Delta M_{S,m}$	[%]	Relative mass difference after 28 exposition's days (to sulphate) (mean value)
$\Delta R_{cS,m}$	[%]	Relative compression resistance difference after 28 exposition's days (to sulphate) (mean value)
N_{dS}	[n]	Number of days to induce failure (exposure to sulphates)
$M_{D28,i}$	[g]	Dry mass of the specimen after 28 exposition's days (to de-icing salts)
$R_{D28,i}$	[MPa]	Compression Resistance of the specimen after 28 exposition's days (to de-icing salts)
$R_{Dr,i}$	[MPa]	Final compression resistance of the reference
$R_{Dr,m}$	[MPa]	Final compression resistance of the reference (mean value)
$\Delta M_{S,i}$	[g]	Relative mass difference after 28 exposition's days (to de-icing salts)
$\Delta R_{cS,i}$	[%]	Relative compression resistance difference after 28 exposition's days (to de-icing salts)
$\Delta M_{D,m}$	[%]	Relative mass difference after 28 exposition's days (to de-icing salts) (mean value)
$\Delta R_{cD,m}$	[%]	Relative compression resistance difference after 28 exposition's days (to de-icing salts) (mean value)
N_{dD}	[n]	Number of days to induce failure (exposure to de-icing salts)
$M_{W30,i}$	[g]	Dry mass of the specimen after 30 exposition's cycles (to sea salts)
$R_{W30,i}$	[MPa]	Compression resistance of the specimen after 30 exposition's cycles (to sea salts)
$R_{Wr,i}$	[MPa]	Final compression resistance of the reference
$R_{Wr,m}$	[MPa]	Final compression resistance of the reference (mean value)
$\Delta M_{W,i}$	[g]	Relative mass difference after 30 exposition's cycles (to sea salts)
$\Delta R_{cW,i}$	[%]	Relative compression resistance difference after 30 exposition's cycles (to sea salts)
$\Delta M_{W,m}$	[%]	Relative mass difference after 30 exposition's cycles (to sea salts) (mean value)
$\Delta R_{cW,m}$	[%]	Relative compression resistance difference after 30 exposition's cycles (to sea salts) (mean value)
N_{cW}	[n]	Number of days to induce failure (exposure to sea salts)

Content of soluble salts

γ_7	[µS/cm]	Specific conductivity after 7 days of curing
γ_{28}	[µS/cm]	Specific conductivity after 28 days of curing
$I_{Ca}\%$	[%]	Percentage of dry mass of the specimen (Ca^{2+} ion)
$I_{Na}\%$	[%]	Percentage of dry mass of the specimen (Na^+ ion)
$I_K\%$	[%]	Percentage of dry mass of the specimen (K^+ ion)
$I_{Mg}\%$	[%]	Percentage of dry mass of the specimen (Mg^{2+} ion)
$I_{Cl}\%$	[%]	Percentage of dry mass of the specimen (Cl^- ion)
$I_{SO4}\%$	[%]	Percentage of dry mass of the specimen (SO_4^{2-} ion)

Heat of hydration

H_7	[J/g]	heat of hydration after 7 days
H_{28}	[J/g]	heat of hydration after 28 days
Q_a	[J/g]	heat of solution of the anhydrous "Natural Binder"
Q_7	[J/g]	heat of solution of the "Natural Binder" after 7 days of hydration
Q_{28}	[J/g]	heat of solution of the "Natural Binder" after 28 days of hydration

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the “Natural Binder” is established in relation to the essential characteristics.

Table 2.1.1: Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Available lime	2.2.1	Level **available $w\mathrm{Ca(OH)_2}$** [$\%_{w}$]
2	Compressive strength	2.2.2	Level **$R_{C,7}$** [MPa] **$R_{C,28}$** [MPa] **$R_{C,56}$** [MPa]
3	Setting time	2.2.3	Level **T_{Si}** [min] **T_{Sf} [min]**
4	Particle Size	2.2.4	Level **R_{63}** [%] **R_{125}** [%]
5	Modulus of elasticity in compression	2.2.5	Level **$E_{M,C}$** [MPa]
6	Water vapour absorption	2.2.6	Level **MBV** [g/(m^2%$_{RH}$]
7	Water absorption coefficient and drying rate	2.2.7	Level *Water absorption coefficient* **$C_{90,m}$** [kg/(m^{2}min$^{0.5}$)] **$C_{24h,m}$** [kg/m^2] **$h_{24h,m}$** [mm] *Drying* **$W_{A,m}$** [%] **$M_{A,m}$** [g] **D_R** [g/h]
8	Soundness	2.2.8	Level **Sdn** [mm]
9	Sulphate content (expressed as SO_3)	2.2.9	Level **wSO_3** [$\%_{w}$]
10	Air content	2.2.10	Level [%]

11	Penetration	2.2.11	Level [mm]
Basic Works Requirement 3: Hygiene, health and the environment			
12	Content, emission and/or release of dangerous substances	2.2.12	Description
Aspects of Durability			
13	Content of C_3A Content of C_3S Content of other silicates and aluminates	2.2.13.1 2.2.13.2 2.2.13.3	**%C_3A** [%] **%C_3S** [%] *Other silicates and aluminates* **%C_2S** [%] **%CS** [%] **%C_4AF** [%]
14	Sulphate resistance	2.2.14	Level **$\Delta R_{cS,m}$** [%], **$\Delta M_{S,m}$** [%], **N_{dS}** [n] Description
15	Resistance to de-icing salts	2.2.15	Level **$\Delta R_{cD,m}$** [%], **$\Delta M_{D,m}$** [%], **N_{dD}** [n] Description
16	Resistance to sea salts	2.2.16	Level **$\Delta R_{cW,m}$** [%], **$\Delta M_{W,m}$** [%], **N_{cW}** [n] Description
17	Content of soluble salts	2.2.17	Level $\gamma_{,7}$ [µS/cm] $\gamma_{,28}$ [µS/cm] **I_{Ca}%** [%] **I_{Mg}%** [%] **I_{Na}%** [%] **I_{K}%** [%] **I_{Cl}%** [%] **I_{SO4}%** [%]
18	Heat of hydration	2.2.18	Level **H_7** [J/g] **H_{28}** [J/g]

2.2 Methods and criteria for assessing and classification of the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

2.2.1 Available lime

The content of available lime of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 6.9. The terms “all types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

Content of available lime, expressed as available $Ca(OH)_2$ in percent of mass fraction: **available $w\mathbf{Ca(OH)_2}$** [$\%_w$] shall be stated in the ETA.

Note. The content of available lime shall be less than 15% as defined in clause 1.1.

2.2.2 Compressive strength

The compressive strength of the “Natural Binder” shall be tested and assessed in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder”.
2 specimens shall be tested for each maturation time (7, 28 and 56 days).

The following performances shall be stated in the ETA:

- Mean value of compressive strength of 2 specimens (7 days): $R_{C,7}$ [MPa],
- Mean value of compressive strength of 2 specimens (28 days): $R_{C,28}$ [MPa],
- Mean value of compressive strength of 2 specimens (56 days): $R_{C,56}$ [MPa].

2.2.3 Setting time

The setting time of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 7.5. The terms “Lime”, when mentioned in the EN 459-2, shall be considered “Natural binder".
The water / binder ratio can be determined with a standard consistence test in accordance with EN 459-2, section 7.5.3.

The initial setting time, expressed in minutes: $\mathbf{T_{Si}}$ [min] shall be stated in the ETA.

The final setting time, expressed in minutes: $\mathbf{T_{Sf}}$ [min] shall be stated in the ETA.

2.2.4 Particle size

The particle size of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 7.2, with the following modification of the test sieves. The terms “all types of lime with hydraulic properties” or “building lime”, when mentioned in the EN 459-2, shall be considered “Natural Binder".
The test sieves to be used in the tests shall have the aperture sizes of 0,063 mm and 0,125 mm (instead of aperture sizes of 0,090 mm and 0,200 mm as indicated in the EN 459-2).

The following performance shall be stated in the ETA:

- Mass retained on each sieve, 0,063 mm, expressed in percent of mass fraction: R_{63} [%],
- Mass retained on each sieve, 0,125 mm, expressed in percent of mass fraction: R_{125} [%].

2.2.5 Modulus of elasticity in compression

The modulus of elasticity of the “Natural Binder” shall be determined in accordance with EN 13412, method 2. The preparation of test specimens and test procedure are specified in Annex A.

Mean secant modulus for the 3 specimens, expressed to the nearest 100 MPa: $E_{M,C}$ [MPa] shall be stated in the ETA.

2.2.6 Water vapour absorption

The water vapour absorption of the “Natural Binder” shall be determined in accordance with the method specified in Annex B.

Moisture buffer value, the mean value of Δm per m^2 and per % RH of the specimens: **MBV** [g/($m^2\%_{RH}$)] shall be stated in the ETA.

2.2.7 Water absorption coefficient and drying rate

2.2.7.1 Water absorption coefficient (for capillary action)

The water absorption coefficient due to capillary action of the “Natural Binder” shall be determined in accordance with the method of EN 1015-18.
The preparation of test specimens and the calculation and expression of results are specified in Annex C through a standardized mortar.

The following performances shall be stated in the ETA:

- Water absorption coefficient evaluated after 90 minutes: $C_{90,m}$ [kg/($m^2min^{0.5}$)],
- Water absorption coefficient evaluated after 24 hours: $C_{24h,m}$ [kg/m^2],
- Depth of water penetration: $h_{24h,m}$ [mm].

2.2.7.2 Drying rate

The drying rate of the “Natural Binder” shall be determined in accordance with the method specified in Annex D.

The following performances shall be stated in the ETA

- Average percentage of water absorbed by the specimens: $W_{A,m}$ [%],
- Average mass of water absorbed the specimens placed in immersion: $M_{A,m}$ [g],
- Average drying rate: D_R [g/h].

2.2.8 Soundness

The soundness of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 7.4. The reference method described in section 7.4.2.1 of the EN 459-2 shall be used.

At least three specimens of the same specimen of binder shall be tested.

The soundness, expressed in millimetres: $S_{dn} = D_e – D_i$ [mm] shall be stated in the ETA.

2.2.9 Sulphate content (expressed as SO_3)

The sulphate content of the “Natural Binder”, expressed as SO_3, shall be determined in accordance with EN 459-2 as specified in section 6.4. The terms “building lime”, when mentioned in the EN 459-2, shall be considered as “Natural Binder”.

Sulphate content, expressed as SO_3 content: ***w*SO₃** → $\boldsymbol{w}\mathbf{SO_3}$ [$\%_w$] shall be stated in the ETA.

2.2.10 Air content

The air content of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 7.10.

The air content, expressed in percentage: **Air content** [%], shall be stated in the ETA.

2.2.11 Penetration

The penetration value of the “Natural Binder” shall be determined in accordance with EN 459-2 as specified in section 7.8.

The penetration, expressed in millimetres: **Penetration** [mm], shall be stated in the ETA.

2.2.12 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed based on the information provided by the manufacturer[3] after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The intended release scenarios for this product and intended use with respect to dangerous substances for this product are:

IA1: Product with direct contact to indoor air

S/W1: Product with direct contact to soil, ground and surface water

2.2.12.1 SVOC, VOC and polycyclic aromatic hydrocarbons (PAH)

For inorganic products, without intentionally added organic compounds, the product shall not be tested.

If the above is not applicable the following procedure shall be performed.

For the intended use covered by the release scenario IA1, semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) shall be determined in accordance with EN 16516.

Loading factors L in accordance with EN 16516, depending on the product type, as specified in table 2.2.12.1:

Table 2.2.12.1: Loading factors L depending on the intended use

Intended use	Loading factor [m^2/m^3]
Any	1.0

The preparation of the test specimen is performed by using a representative specimen of the Natural binder installed in accordance with the manufacturer’s product installation instructions or in absence of such instructions the usual practice of the product installation. The size of the test specimen shall be chosen in consideration of the test chamber size and intended loading factor.

Once the test specimen has been produced, as described above, it shall be immediately placed in the emission test chamber. This time is considered the starting time of the emission test.

---

[3] The manufacturer may be asked to provide to the TAB the REACH related information which shall accompany the DoP (cf. Article 6(5) of Regulation (EU) No 305/2011).
The manufacturer is not obliged to:
- provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous in accordance with Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS, taking into account the installation conditions of the construction product and the release scenarios resulting from there.

Any information provided by the manufacturer regarding the chemical composition of the products is not to be distributed to EOTA, to other TABs or beyond.

A standard mixture with composition as described below in 2.2.12.2 shall be tested, and special mixes requested by the manufacturer can be tested in addition.

The test results shall be reported for the relevant parameters (e.g., chamber size, temperature and relative humidity, air exchange rate, loading factor, size of test specimen, conditioning, production date, arrival date, test period, test result) after 3 and/or 28 days testing.

Description of the content of SVOC, VOC and polycyclic aromatic hydrocarbons (PAH) shall be stated in the ETA.

2.2.12.2 Leachable substances

For the intended use covered by the release scenario S/W1 the performance of the product concerning leachable substances shall be assessed. A leaching test with subsequent eluate analysis shall take place, each in duplicate.

Elution test specimens shall be made of concrete with the following composition:

- Binder: “Natural Binder”, c = 280 kg/m^3
- Water / binder ratio: 0,6
- Aggregate: gravel sand in accordance with EN 12620 with the grading curve specified in table 2.2.12.2.1 and figure 2.2.12.2.1:

Table 2.2.12.2.1: Gravel sands granulometric curve

Size [mm]	0.25	0.5	1	2	4	8	16
Passing [% by mass]	6	14	22	32	46	68	100

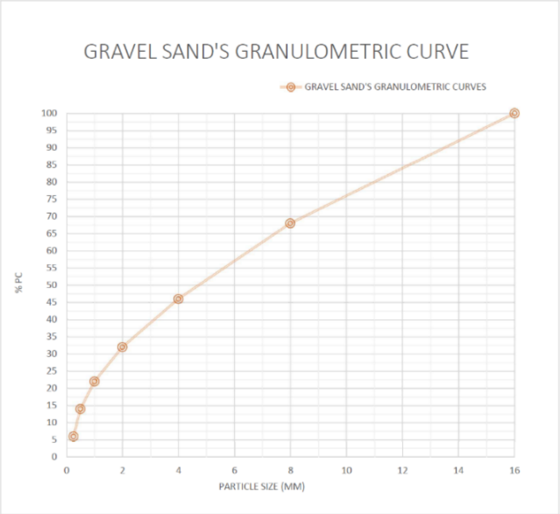

Figure 2.2.12.2.1: Gravel sands granulometric curve

“Natural Binder” cubes with dimensions of 100 mm × 100 mm × 100 mm shall be made in accordance with EN 12390-2 (form oil must not be used). Usually, the cubes are removed from the forms after 3 days.

After removal from the forms, the test specimens are tightly packaged and stored at a temperature of (20 ± 2) °C. The test specimens are generally stored for 56 days. The requirements for storage are fulfilled, when the cubes, for instance, are immediately double wrapped in plastic foil (at least 0,3 mm thick), and all free edges of the plastic foil are stuck down with adhesive tape.

The eluate is produced by a tank test in accordance with EN 16637-2. The leachant shall be pH-neutral demineralized water and the ratio of liquid volume to surface area shall be (80 ± 10) l/m^2. The eluates taken after 6 hours, 1 day, 2 days and 6 hours, 4 days, 9 days, 16 days, 36 days and 64 days shall be analysed for the following environmentally relevant parameters:

- Heavy metals: antimony, arsenic, barium, lead, cadmium, chromium (total), chromate (Cr VI), cobalt, copper, molybdenum, nickel, mercury, thallium, vanadium, zinc. These parameters shall be analysed in accordance with CEN/TR 16192.

- chloride (Cl^-) (*), sulphate (SO_4^{2-}) (*), fluoride (F^-) (*). These parameters shall be analysed in accordance with EN ISO 10304-1.
- TOC (**). This parameter shall be analysed in accordance with EN 1484.
- pH-value, electrical conductivity (*), odour, colour, turbidity, and tendency to produce foam. These parameters shall be analysed in accordance with EN 16192.

(*) If these parameters are assessed in the pt. 2.2.17 "Content of soluble salts", this shall be stated in the ETA.

(**) for inorganic products, without intentionally added organic compounds, the product shall not be tested.

Measured concentration of the leaching test in accordance with EN 16637-2 of hardened mixture must be expressed per step for each parameter in µg/l and mg/m^2. Additionally, the cumulatively released quantities must be expressed for each parameter in mg/m^2.

The used test methods for the analysis of the parameters shall be documented including method detection limits.

Description of the content of leachable substances shall be stated in the ETA.

2.2.12.3 Natural radioactivity

The natural radioactivity content of the "Natural Binder", shall be determined in accordance with EN ISO 20042.

Description of the content of natural radioactivity shall be stated in the ETA.

2.2.13 Content of C_3A, C_3S and other silicates and aluminates

2.2.13.1 Content of C_3A

The calcium aluminate content of the product shall be determined with the XRD-analysis with Rietveld refinement in accordance with Annex E.

The following performances shall be stated in the ETA:

- C_3A content, expressed in mass fraction in percent: %C_3A [%].

2.2.13.2 Content of C_3S

The calcium silicate content of the product shall be determined with the XRD-analysis with Rietveld refinement in accordance with Annex E.

The following performances shall be stated in the ETA:

- C_3S content, expressed in mass fraction in percent: %C_3S [%].

2.2.13.3 Content of other silicates and aluminates

The other silicates and aluminates content of the product shall be determined with the XRD-analysis with Rietveld refinement in accordance with Annex E.

The following performances shall be stated in the ETA:

- C_2S content, expressed in mass fraction in percent: %C_2S [%],
- CS content, expressed in mass fraction in percent: %CS [%],
- C_4AF content, expressed in mass fraction in percent: %C_4AF [%].

2.2.14 Sulphate resistance

The sulphate resistance of the "Natural Binder" shall be determined in accordance with the method specified in Annex F.

The following performance shall be stated in the ETA:

- Relative compression resistance difference after 28 exposition's days: $\Delta R_{cS,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Relative mass difference after 28 exposition's days: $\Delta M_{S,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Number of days to induce failure of the specimens: NdS [n] or, in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*no failure of the specimens during the conditioning*" shall be stated in the ETA.

2.2.15 Resistance to de-icing salts

The de-icing salts resistance of the "Natural Binder" shall be determined in accordance with the method specified in Annex G.

The following performances shall be stated in the ETA:

- Relative compression resistance difference after 28 days exposition: $\Delta R_{cD,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Relative mass difference after 28 days exposition: $\Delta M_{D,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Number of days to induce failure: N_{dD} [n] or, in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*no failure of the specimens during the conditioning*" shall be stated in the ETA.

2.2.16 Resistance to sea salts

The sea salts resistance of the "Natural Binder" shall be determined in accordance with Annex H which is based on EN 12370.

The following shall be stated in the ETA:

- Relative compression resistance difference after 30 cycles: $\Delta R_{cW,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Relative mass difference after 30 exposition cycles: $\Delta M_{W,m}$ [%] or, in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be stated in the ETA.
- Number of cycles to induce failure: N_{cW} [n] or, in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*no failure of the specimens during the conditioning*" shall be stated in the ETA.

2.2.17 Content of soluble salts

The content of soluble salts of the "Natural Binder" shall be determined in accordance with EN 16455 with some modification relevant to the salt extraction process and the preparation of water specimens to be analysed as specified in Annex I.

The following performances shall be stated in the ETA:

- Water's Electric Conductivity after 7 days of curing: γ_7 [µS/cm],

- Water’s Electric Conductivity after 28 days of curing: γ_{28} [µS/cm],
- Water’s ion content (Ca^{++}), expressed in part per million: I_{Ca}% [%],
- Water’s ion content (Mg^{++}), expressed in part per million: I_{Mg}% [%],
- Water’s ion content (Na^{+}), expressed in part per million: I_{Na}% [%],
- Water’s ion content (K^{+}), expressed in part per million: I_{K}% [%],
- Water’s ion content (Cl^{-}), expressed in part per million: I_{Cl}% [%],
- Water’s ion content (SO_4^{--}), expressed in part per million: I_{SO4}% [%].

2.2.18 Heat of hydration

The heat of hydration of “Natural Binder” shall be determined in accordance with Annex J.

The procedures in Annex J are based on the EN 196-8.

The following performances shall be stated in the ETA:

- The heat of hydration after 7 days: H_7 [J/g],
- The heat of hydration after 28 days: H_{28} [J/g].

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 97/555/EC amended by EC Decision 2010/683/EU.

The system is 1+.

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the Natural Binder” made from “Scaglia Rossa” marl for construction mixtures, in the procedure of assessment and verification of constancy of performance, are laid down in Table 3.2.1.

Table 3.2.1: Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Incoming raw material	Visual check L.O.I. Measuring of the composition in oxides of the marl: CaO; SiO_2; Al_2O_3; Fe_2O_3, in accordance with EN 196-2	According to the control plan	According to the control Plan	Each delivery According to the control plan (*)
2	Particle size of the product	See 2.2.4	According to the control plan	1	Each production day / Each 4 hours of production*
3	Available lime of the product	See 2.2.1	According to the control plan	1	1 / week (**)
4	Setting time of the product	See 2.2.3	According to the control plan	1	1 / week (**)
5	Soundness of the product	See 2.2.8	According to the Control plan	1	1 / week (**)
6	Sulphate (expressed as SO_3) of the product	See 2.2.9	According to the control plan	1	2 / month (**)
7	Content of C_3A, C_3S and other silicates and aluminates of the product	See 2.2.13	According to the control plan	1	2 / month (**)
8	Compressive strength of the product	See 2.2.2	According to the control plan	1	1 / week (**)
9	Heat of hydration of the product	See 2.2.18	According to the control plan	1	1 / 2 months (**)
10	Penetration value of the product	See 2.2.11	According to the control plan	1	1 / month (**)
11	Content of soluble salts of the product	See 2.2.17	According to the control plan	1	2 / year (**)
12	Modulus of elasticity in compression of the product	See 2.2.5	According to the control plan	1	1 / year (**)
13	Sulphate resistance	See 2.2.14	According to the control plan	1	1 / 2 years
14	Resistance to de-icing salts	See 2.2.15	According to the control plan	1	1 / 2 years
15	Resistance to sea salt	See 2.2.16	According to the control plan	1	1 / 2 years
16	Water vapour absorption	See 2.2.6	According to the control plan	1	1 / 2 years
17	Water absorption and drying rate	See 2.2.7	According to the control plan	1	1 / 2 years

(*) The frequency is determined on the type of production process, the variation in the volume produced and the production process control.

(**) Initial period (3 months) twice the frequency indicated.

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body of the “Natural Binder” made from “Scaglia Rossa” marl for construction mixtures in the procedure of assessment and verification of constancy of performance are laid down in Table 3.3.1.

Table 3.3.1: Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the natural binder	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to Control plan	According to Control plan	1/year
Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities *(for system 1+ only)*					
1	Available lime of the product	See 2.2.1	According to the control plan	1	1/year
2	Soundness of the product	See 2.2.8	According to the Control plan	1	1/year
3	Sulphate (expressed as SO_3) of the product	See 2.2.9	According to the control plan	1	1/year
4	Content of C_3A, C_3S and other silicates and aluminates of the product	See 2.2.13	According to the control plan	1	1/year
5	Compressive strength of the product	See 2.2.2	According to the control plan	1	1/year
6	Heat of hydration of the product	See 2.2.18	According to the control plan	1	1/year
7	Content of soluble salts of the product	See 2.2.17	According to the control plan	1	1/year
8	Modulus of elasticity in compression of the product	See 2.2.5	According to the control plan	1	1/year
8	Water absorption and drying rate	See 2.2.7	According to the control plan	1	1/ 2 years

4 REFERENCE DOCUMENTS

EN 196-1:2016	Methods of testing cement – Part 1: Determination of mechanical resistance
EN 196-2:2013	Methods of testing cement - Part 2: Chemical analysis of cement
EN 196-7:2007	Methods of testing cement – Part 7: Methods of taking and preparing samples of cement
EN 196-8:2010	Methods of testing cement – Part 8: Heat of hydration – Solution method
EN 206:2013+A2:2021	Concrete – Specification, performance, production and conformity
EN 459-1:2010	Building lime – Part 1: Definitions, specifications, and conformity criteria
EN 459-2:2021	Building lime – Part 2: Test methods
EN 1015-18:2002	Determination of water absorption coefficient due to capillary action of hardened mortar
EN 1484:1997	Water analysis - Guidelines for the determination of total organic carbon (TOC) and dissolved organic carbon (DOC)
EN 12370:2020	Natural stone test methods – Determination of resistance to salt crystallisation
EN 12390-2:2019	Testing hardened concrete - Part 2: Making and curing specimens for strength tests
EN 12620:2013	Aggregates for concrete
EN 13412:2006	Products and systems for the protection and repair of concrete structures – Test methods – Determination of modulus of elasticity in compression
CEN/TR 16192:2020	Waste – Guidance on analysis of eluates
EN 16455:2014	Conservation of cultural heritage – Extraction and determination of soluble salts in natural stone and related materials used in and from cultural heritage
EN 16516:2017+A1:2020	Construction products: Assessment of release of dangerous substances - Determination of emissions into indoor air
EN 16637-2:2023	Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test.
EN ISO 10304-1:2009+AC:2012	Water quality - Determination of dissolved anions by liquid chromatography of ions - Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate (ISO 10304-1:2007+Cor1:2010)
EN ISO 11885:2009	Water quality - Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES) (ISO 11885:2007)
EN ISO 20042:2021	Measurement of radioactivity - Gamma-ray emitting radionuclides - Generic test method using gamma-ray spectrometry

ANNEX A: MODULUS OF ELASTICITY IN COMPRESSION

The following procedures are based on the EN 13412.

A.1 Scope

The scope of this method is to evaluate the modulus of elasticity in compression value for the “Natural Binder”. Method 2 for products and systems with low creep characteristics shall be applied.

Method 2 of the EN 13412 is for products and systems with low creep characteristics, typically those containing polymer modified (PCC) and cementitious (CC) binders, as the product of this EAD.

A.2 Principle

The principle is described in the section 4 of EN 13412.

Method 2 for products and systems with low creep resistance shall be applied.

A.3 Equipment

The equipment is described in the section 5 of EN 13412.

A.4 Preparation of test specimens

The components shall be prepared in accordance with the section 6 of EN 13412 with the following specifications.

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (60 ± 10) $\%_{RH}$) for at least 24h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm x 40 mm x 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

At least three prism specimens shall be tested.

The specimens shall be cured and stored as described in A.7. The mould shall be removed 5 days after preparation of the test specimens.

A.5 Procedure

The procedure is described in the section 7.5 of EN 13412 with the following specifications:

- **Conditions and conditioning**: Immediately prior to testing, the test specimens shall be conditioned for at least 24h under the standard conditions laid down in A.4.
- **Measurement**: Measure the width and thickness of each specimen from the middle to the nearest 0.1 mm, to calculate the cross-sectional area.
- **Fitting strain measuring Instruments**: When attaching a strain gauge (strain gauges with a gauge length of at least 50 mm, a maximum sensitivity of 50 µm/m that provide a continuous indication of change in gauge length) to a specimen, ensure that the strain measurement is parallel to the longitudinal axis of the prism and any distortion about the axis is eliminated. There shall be no slippage between the grips of mechanical strain gauges and the specimen.
- **Method 2**: The secant modulus is established by measuring the change in the strain in the specimen when loaded to produce a stress of between 0,2 [MPa] (σ_2) and one-third of the compressive strength (σ_c) of the specimen, measured in accordance with section 2.2.2. of this EAD.

- **Pre-Loading**: Place the test specimen, with the strain measuring instruments attached axially and centrally in the machine. Apply the basic stress of 0,2 [MPa] (σ_2) and record the strain (ε_i). Steadily increase the stress at a constant rate within the range (0,2 ± 0,1) MPa/s until a stress equal to one-third of the compressive strength (σ_c) of the specimen ($\sigma_1 = \sigma_c /3$) is reached. The preferred rate of stress application is 0,1 MPa/s.

  Maintain the stress for 60 s and record tile strain readings taken during the following 30 s (ε_f). If the individual strain readings on the specimen are not within a range ±10% of their mean value at (σ_1), re-centre the test specimen and repeat the pre-loading.

  If it is not possible to reduce the differences to within a range of ± 10 % of their mean value at σ_1, do not proceed with the test loading. Carry out at least two additional preloading cycles, using the same loading and unloading rate, and maintaining the stress (σ_1 and σ_2) at a constant for a period of 60 s.

- **Test loading**: After completing the last preloading cycle and after a waiting for a period of 60s under the stress (σ_2), measure the change in the compressive strain ($\Delta\varepsilon$) as the stress is increased from σ_2 to σ_1, calculating ($\Delta\sigma$) as the difference between the two levels of applied stress (i.e., σ_1 - σ_2). Measurements of (σ_1) and ($\Delta\varepsilon$) shall be completed within 30 s. When all measurements have been completed, remove the strain measuring instruments where applicable and then increase the load on the test specimen, at the specified rate, until failure of the specimen occurs and calculate the failure stress (σ_f). If the compressive strength of the specimen at failure (σ_f) differs from (σ_c) by more than 20 %, this shall be noted in the test report.

A.6 Calculation and value expression

The differences of the compressive strain ($\Delta\varepsilon$) and the difference of the compressive stress ($\Delta\sigma$) shall be calculated with respectively equation (A.6.1) and (A.6.2):

$$\Delta\varepsilon = (\varepsilon_f - \varepsilon_i) \quad \text{[MPa]} \tag{A.6.1}$$

$$\Delta\sigma = (\sigma_1 - \sigma_2) \quad \text{[mm]} \tag{A.6.2}$$

Calculate the secant modulus for each specimen by dividing ($\Delta\sigma$) by ($\Delta\varepsilon$) as in equation (A.6.3).

$$E_{M,C} = \frac{\Delta\sigma}{\Delta\varepsilon} \quad \text{[GPa]} \tag{A.6.3}$$

Calculate the mean secant modulus for the three specimens. The mean value to the nearest 100 MPa shall be stated in the ETA.

A.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 196-1, keep the moulds in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in a climatic chamber for 2 days (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (60 ± 10) $\%_{RH}$ for 28 days.

Conditioning and Testing:

- Take the prisms from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (60 ± 10) $\%_{RH}$ for 30 min before using them for tests.

A.8 Report

The test report shall be prepared in accordance with section 9 of EN 13412.

ANNEX B: WATER VAPOUR ABSORPTION

B.1 Scope

The scope of this method is to evaluate the moisture buffer (see the definition below) value for construction materials exposed to indoor air. The test is intended to simulate daily variations.

B.2 Definitions

Moisture buffer value in this procedure refers to the moisture uptake/release when the material is exposed to a square wave in relative humidity between 75 $\%_{RH}$ (relative humidity) for 8 hours and 33 $\%_{RH}$ for 16 hours. The value is normalized per exposed surface area and change in RH.

B.3 Test method

B.3.1 Principle

A test specimen, partly sealed, is exposed to repeated step changes in ambient relative humidity. The temperature is held constant at 23°C. Because of the change in RH, the specimen will gain or lose weight. The weight change of the specimen is monitored continuously or by frequent weighing. The change in weight over certain durations of time can be considered as an expression of the moisture buffer value of the test specimen.

B.3.2 Experimental equipment

- A climate chamber/climate box where temperature and RH can be kept constant and where the proposed RH-step can be performed shall be used. Suitable sensors and a logging system to continuously record the temperature and the relative humidity within the test chamber shall be used. The sensors shall be calibrated at regular intervals.
- An analytical balance, capable of weighing the test specimens with the repeatability of 1 % shall be used. That means for example for a test specimen with a change in mass of 1 g per 8 hours, a balance with a resolution of 0,01 g or better shall be used, correspondingly for a test specimen with a change in mass of 10 g per 8 hours, a resolution of 0,1 g or better can be used.
  Moulds for the preparation of the specimens. The specimens shall be 30 mm x 150 mm x 150 mm plate specimen.
- Sealing material (for example aluminium tape) to avoid the moisture absorption of the specimens.

The air in the test chamber shall circulate and the air velocity shall be (0,10 ± 0,05) m/s like in a normal indoor environment. However, the air circulation shall not disturb the balance, or it shall be switched off during weighing.

B.3.3 Test specimens

B.3.3.1 General

The test specimens shall be representative of the product. At least three plates are required as test specimens.

B.3.3.2 Preparation and curing of test specimens

The components of the product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (60 ± 10) $\%_{RH}$ for at least 24h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall be compacted into mould with a dimension of 150 mm x 150 mm x 30 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder". At least three plates are required as test specimens.

Moulds with the dimensions and tolerances indicated in Figure B.3.3.2.1 shall be used for the preparation of the specimens.

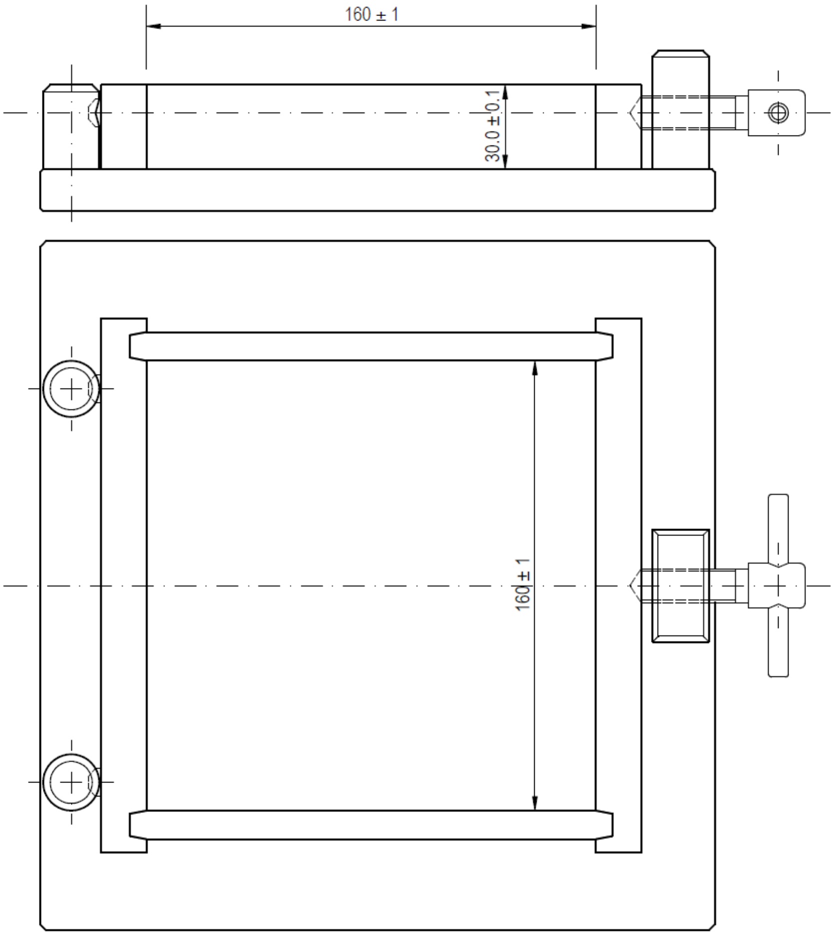

Figure B.3.3.2.1: Image of the mould and loading hopper with dimension and tolerances

The specimens shall be covered in film for 5 days. The mould shall be removed 5 days after preparation of the test specimens. Then the specimens shall be cured in air at (21 ± 2) °C and (60 ± 10) $\%_{RH}$ for other 23 days.

B.3.3.3 Exposed area

The specimens shall be 30 mm x 160 mm x 160 mm plate . The area (A_N) shall be determined within an accuracy of 1%.

B.3.4 Sealing of specimen

Plate test specimens shall be sealed on 5 out of 6 sides. The upper side of the specimen, with 150 mm × 150 mm dimension, shall be left unsealed. Sealing materials shall not absorb moisture. An example of a good sealing material is aluminium tape. The sealing material shall have a good adherence to the substrate, and it shall be ensured that moisture movement of the substrate does not cause loosening of the sealing material.

B.3.5 Conditioning of test specimens

Before testing, the test specimens shall be stored and at first, they shall be brought in equilibrium with air at (23 ± 2) °C and (50 ± 5) $\%_{RH}$. The criterion for equilibrium is a period long enough for the weight of the specimen to be stabilised so that two successive daily determinations (24 hours between) of the weight agree to within 0,1 % of the mass of the test specimen.

B.4 Test procedure

B.4.1 Test conditions

The test environments are given in Table B.4.1.1. and in the relative diagram (Figure B.4.1.1). Test conditions can be maintained by saturated salt solutions or it can be maintained by some other mechanism in a climatic chamber.

Table B.4.1.1: Test condition (T and RH)

Temperature (° C)	RH (%)	Time (h)
23	33	16
23	75	8

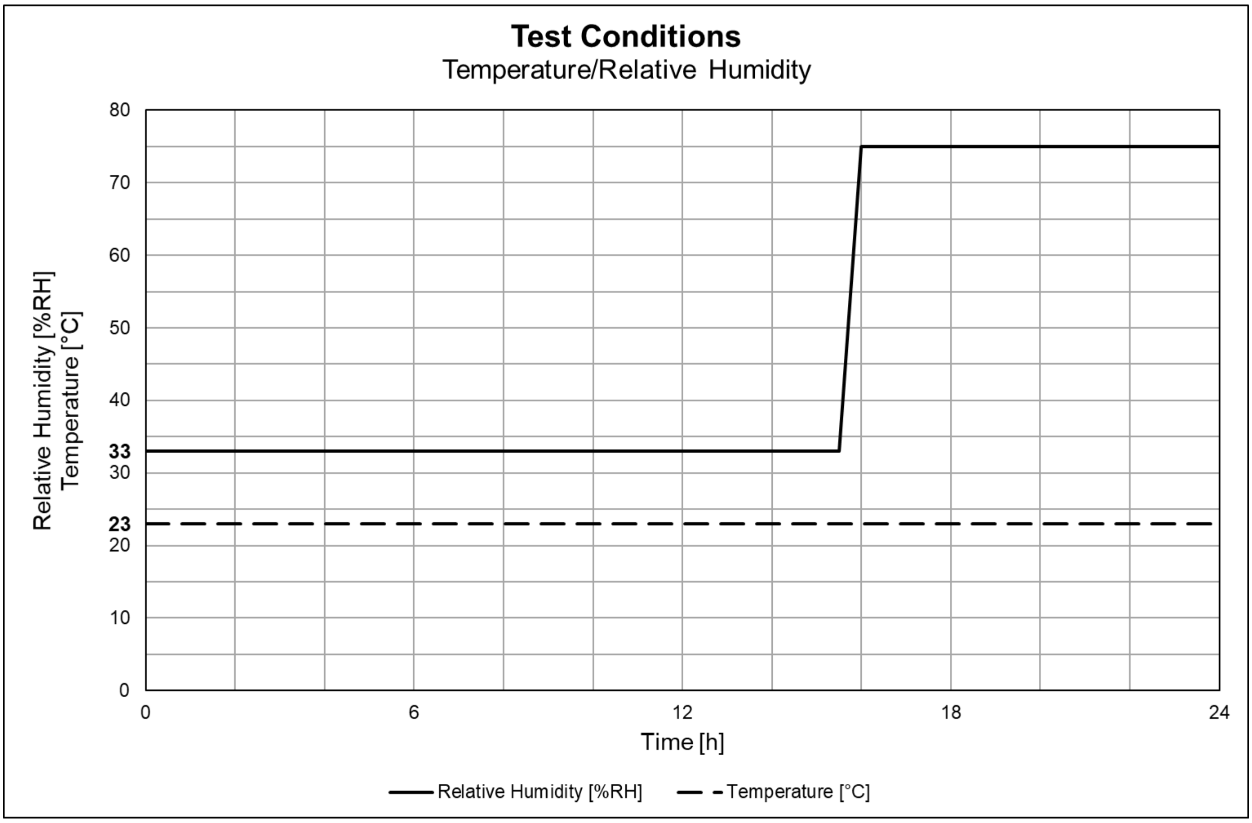

Figure B.4.1.1: Diagram of the test condition (T and HR versus time)

The high RH level shall last for 8 hours (± 10 min.). The low RH level shall last for 16 hours (± 10 min.). If the step changes of relative humidity cannot be achieved instantly, they shall be realized to an accuracy of ± 3 $\%_{RH}$ within at the most 30 minutes after the intended change. The intended temperature shall be maintained within ±0,5 °C.

The cyclic exposure shall continue until the change in mass, ((Δm) [g]), is less than 5 % between the last three cycles (days). In each cycle Δm shall be determined as the average between the weight gain during the moisture uptake branch of the cycle, and the weight loss during drying. Also, the difference between weight gain and weight loss within each cycle shall be less than 5% of Δm.

If the weight gains and losses are not monitored continuously, at least 1 weighing shall be done by the turn of each exposure in the cycle. The specimen shall be weighed a minimum of 5 times during the 8 hours absorption periods during the last three days.

B.4.2 Preparation of specimen and test facility

Prepare test specimens. Measure the thickness and the exposed area before and after the sealing has been done.

B.4.3 Test procedure

Place the test specimens in the test chamber.

Perform the weighing. The weight shall be determined in an environment with a temperature within +/- 2 °C of the test condition, wherever possible within the test chamber. Movement to scale shall not influence the result by more than 1 % of the amplitude.

Plot a curve of the mass against time.

B.5 Calculation and value expression

The result shall be calculated as mass-change, Δm, per m^2 and per ΔRH, using equation (B.5.1). Two results of mass change shall be calculated for each cycle: one for the weight gain during absorption (m_{8h}-m_0), the second for the weight loss during drying (m_{24h} -m_{8h}). The average between the absorption and release weight changes shall be calculated in each cycle. The Moisture Buffer Value (MBV) is the figure calculated on the basis of the mean of at least 3 cycles, using equation (B.5.2).

$$\Delta m = (m_{24h} - m_{8h}) - (m_{8h} - m_0) \text{ [g]} \qquad (B.5.1)$$

$$MBV = \frac{\Delta m}{\Delta RH * A_N} \quad [g/(m^2\%_{RH})] \qquad (B.5.2)$$

The MBV [$g/(m^2\%_{RH})$] shall be stated in the ETA.

B.6 Report

The test report shall include to the maximum extent applicable at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Thickness, exposed surface area, shape and sealing methods used,
h. Description of the test conditions:
    - test configuration used,
    - conditioning of the specimen carried out,
    - dates of the test,
    - information concerning the apparatus used,
    - picture of the specimen and setup,

i. Result as a Moisture buffer value (MBV).
Plot a curve of the mass against time. The results shall be given as the average of all specimens, and either their standard deviation or the individual results of all tested specimens shall be given. All results shall be given as the average value of the last three stable cycles.

ANNEX C: WATER ABSORPTION COEFFICIENT (FOR CAPILLARY ACTION)

The following procedures are based on the EN 1015-18.

C.1 Scope

The scope of this method is to determine the water absorption coefficient per capillarity of hardened mortars containing "Natural Binder" and normal or light aggregates.

C.2 Principle

The coefficient of water absorption by capillarity is measured by submerging the prism-shaped mortar specimens under expected conditions at atmospheric pressure. After drying to constant mass that do not exceed 0,2% of the total mass, one face (the breaking section) of the specimen is immersed in (5-10) mm of water for a specific period and the mass increase is determined, in conformity to EN 1015-18, section 8.

C.3 Equipment

The equipment is described in the section 5 of EN 1015-18.

C.4 Preparation of test specimens

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for at least 24h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm x 40 mm x 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

At least two prism specimens shall be tested.

The specimens shall be cured and stored as described in C.7. The mould shall be removed 5 days after preparation of the test specimens.

C.5 Procedure

At the end of the curing period, seal the four long faces of the specimens using the specified sealing material described in section 6 of EN 1015-18, then break them into two halves.

Dry the specimens to constant mass in a ventilated oven at a temperature of (55 ± 5) °C. The constant mass is considered to have been reached if two consecutive weighings, 24 hours apart during drying, do not differ by more than 0.2% of the total mass. Record the dry mass of each specimen ($M_{0,i}$).

Follow the indications of EN 1015-18, section 8, making both measurements relating to “restoration mortars” and those relating to “mortars other than restoration mortars”.

Measure the depth of penetration of the water (**$h_{24h,i}$** [mm]) in the centre of the specimen parallel to the dimension of 80 mm, with an accuracy of 1 mm, in accordance with the EN 1015-18, section 8.

C.6 Calculation and value expression

Follow the indications of EN 1015-18, section 9, both in relation to “restoration mortars” and in relation to “mortars other than restoration mortars”.

For "mortars other than restoration mortars" the water absorption coefficient is equal to the slope of the line joining the representative points of the measurements taken at 10 min ($M_{1,i}$) and 90 min ($M_{2,i}$).

It shall be calculated according to the equation (C.6.1):

$$C_{90,i} = 0{,}1 \times (M_{2,i} - M_{1,i}) \qquad [\mathrm{kg/(m^2 min^{0,5})}] \qquad (C.6.1)$$

For restoration mortars only, water absorption is measured in kg/m^2 after 24h using the equation (C.6.2):

$$C_{24h,i} = 0{,}625 \times (M_{3,i} - M_{0,i}) \qquad [\mathrm{kg/m^2}] \qquad (C.6.2)$$

and the depth of water penetration shall be indicated in mm.

The individual values of the water absorption coefficient ($C_{90,i}$, $C_{24h,i}$) shall be calculated to the nearest 0,05 kg/(m^2min$^{0.5}$) or the nearest 0,05 kg/m^2, as applicable.

The mean value of the water absorption coefficient ($C_{90,m}$, $C_{24h,m}$) shall be calculated from the individual values to the nearest 0,1 kg/(m^2min$^{0.5}$) or the nearest 0,05 kg/m^2, as applicable.

The mean value of the depth of water penetration after 24 h ($h_{24h,m}$) shall be calculated from the individual values to the nearest 1 mm.

C.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 459-1, keep the mould in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days at (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in in a climatic chamber for 2 days (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 21 days.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

C.8 Report

The test report shall include to the maximum extent applicable at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Description of the test conditions:
    - Dates of the test,
    - Information concerning the apparatus used,
    - Picture of the specimen and setup,
h. Report of the following results:
    - Average water absorption coefficient after 90 min: $\mathbf{C_{90,m}}$ [kg/(m^2min$^{0.5}$)],
    - Average water absorption coefficient after 24 h: $\mathbf{C_{24h,m}}$ [kg/m^2],
    - Average depth of water penetration after 24 h: $\mathbf{h_{24h,m}}$ [mm].

ANNEX D: DRYING RATE

D.1 Scope

The scope of this method is to determine the drying rate of a hardened mortar made with “Natural Binder”.

D.2 Principle

The drying rate is measured using prism-shaped mortar specimens. After suitable curing, the specimens are dried to constant mass, then they are immersed in water for a specific period, until they are completely wetted (for safety, the specimens are left in water for 7 days) and the mass increase is determined. Then the specimen can be dried in a controlled atmosphere, determining the drying rate over time and the drying time.

D.3 Equipment

Mortar mixer, in accordance with EN 459-2.

Moulds, prism with a dimension of 40mm x 40mm x 160mm in accordance with EN 459-2.

Standard laboratory climate, of (21 ±2) °C and (55±5) $\%_{RH}$.

Ventilated oven for drying the specimens.

Dynamometer for the measurement in continuous of the weight variation of the specimens. The dynamometer shall be able to measure with the accuracy of at least 0,1 N. Equivalently a balance with an accuracy of at least 0,01 g can be used.

D.4 Preparation of test specimens

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for at least 24 h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm x 40 mm x 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

At least three prism specimens shall be tested.

The specimens shall be cured, stored and conditioned as described in D.7. The mould shall be removed 5 days after preparation of the test specimens.

D.5 Procedure

Dry the specimens to constant mass in a ventilated oven at a temperature of (55 ± 5) °C. The constant mass is considered achieved when two consecutive weighings, 24 hours apart during drying, do not differ by more than 0.2% of their total mass.
Record the dry mass of each specimen ($M_{D,i}$).
Place the specimens in a drying location with controlled environmental conditions for 24 h (T = (21 ± 1) °C, HR = (50 ± 2) $\%_{RH}$).
Record the mass of each specimen ($M_{E,i}$), representative of the equilibrium mass of the specimen under the T and HR conditions of the test environment.
Place the specimens in a basin filled with water, taking care to keep the prisms detached from the bottom and check that the specimens remain immersed in water for the entire duration of the test, keeping constant the water level.

Keep the prisms in water for 7 days.
After 7 days, remove the specimens from the basin, quickly dry their surface with a damp cloth, weigh the specimens ($M_{W,i}$) and immediately place them in a drying location with controlled environmental conditions (T = (21 ± 1) °C, HR = (50 ± 2) $\%_{HR}$).

Keep the specimens under controlled environmental conditions, measuring the weight of each specimen with the frequency reported in table D.5.1:

Table D.5.1: Number of mass measurements to be carried out during the test

Time of drying	**Minimum number of data collected**
0 to 8 hours	24
8 hours – 12 hours	8
12 hours – 96 hours	7
4 days – 14 days	120

Draw the resulting drying curve Time against Mass of the specimen. As starting point (t = 0) use the value $M_{W,i}$.

D.6 Calculation and Value expression

Calculate the % by mass of water/moisture absorbed by each specimen in a situation of thermo-hygrometric equilibrium with the surrounding environment ($W_{E,i}$) at the test temperature and humidity conditions (T = (21 ± 1) °C, HR = (50 ± 2) $\%_{HR}$), using equation (D.6.1):

$$W_{E,i} = 100\frac{(M_{E,i}-M_{D,i})}{M_{D,i}} \quad [\%] \qquad (D.6.1)$$

Calculate the mass of water absorbed by each specimen placed in immersion ($M_{A,i}$) using the equations (D.6.2):

$$M_{A,i} = M_{W,i}-M_{E,i} \quad [g] \qquad (D.6.2)$$

Calculate the mass of each specimen at the 10% of drying ($M_{10,i}$) expressed in grams and the mass of each specimen at the 90% of drying ($M_{90,i}$) expressed in grams, using the equations (D.6.3) and (D.6.4):

$$M_{10,i} = M_{E,i} + 0{,}1\ M_{A,i} \quad [g] \qquad (D.6.3)$$

$$M_{90,i} = M_{E,i} + 0{,}9\ M_{A,i} \quad [g] \qquad (D.6.4)$$

Determine the time taken by each specimen to reach 10% drying ($t_{10,i}$) expressed in minutes and 90% drying ($t_{90,i}$) by interpolating the results detected immediately lower and higher than this value.
Determine the mean values of $M_{E,i}$, $M_{10,i}$, $M_{90,i}$, $M_{A,i}$, $t_{10,i}$ and $t_{90,I}$, $W_{E,i}$ that is $M_{e,m}$, $M_{10,m}$, $M_{90,m}$, $M_{e,m}$, $t_{10,m}$, $t_{90,m}$, $W_{E,m}$ by averaging the values obtained individually for the three test prisms.

It is also possible to carry out the operations of measuring the weight of the three specimens all together in the drying phase. In this case the equations (D.6.1), (D.6.2), (D.6.3) and (D.6.4) previously used to calculate the values of $M_{E,I}$, $M_{10,i}$ $M_{90,I}$, $M_{A,I}$, $t_{10,I}$, $t_{90,I}$, $W_{E,I}$ can be used for the direct calculation of the values of $M_{E,m}$, $M_{10,m}$, $M_{90,m}$, $M_{A,m}$, $t_{10,m}$, $t_{90,m}$ and $W_{E,m}$.

$M_{W,m}$: mean value of $M_{W,i}$ for the three specimens.

$M_{D,m}$: mean value of $M_{D,i}$ for the three specimens.

$M_{E,m}$: mean value of $M_{E,i}$ for the three specimens.

$M_{A,m}$: mean value of $M_{A,i}$ for the three specimens.

$W_{E,m}$: mean value of $W_{E,i}$ for the three specimens.

Calculate the average percentage of water absorbed by the specimens ($W_{A,m}$) using the equation (D.6.5):

$$W_{A,m} = 100\frac{(M_{W,m}-M_{E,m})}{M_{E,m}} \quad [\%] \qquad (D.6.5)$$

Calculate the average drying rate (D_R) using the equation (D.6.6):

$$D_R = \frac{(M_{90,m} - M_{10,m})}{(t_{90,m} - t_{10,m})} \text{ [g/h]} \qquad (D.6.6)$$

D.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 459-1, keep the mould in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days at (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in in a climatic chamber for 2 days (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 21 days.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

D.8 Report

The test report shall include to the maximum extent applicable at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Description of the test conditions:
    - Dates of the test,
    - Information concerning the apparatus used,
    - Picture of the specimen and setup,
h. Plotting curve of the mass against time. Report:
    - Average percentage of water absorbed by the specimens: $\mathbf{W_{A,m}}$ [%],
    - Average mass of water absorbed the specimens placed in immersion: $\mathbf{M_{A,m}}$ [g],
    - Average drying rate: $\mathbf{D_R}$ [g/h].

ANNEX E: CONTENT OF C_3A, C_3S AND OTHER SILICATES AND ALUMINATES

E.1 Scope

The scope of this method is to evaluate the content of tricalcium silicate (C_3S), tricalcium aluminate (C_3A) and other silicates and aluminates present in a “Natural Binder” powder specimen.

E.2 Method of test

E.2.1 Experimental equipment

- X-ray diffractometer:
  1. Theta-Theta opening angle of the goniometer: at least 15° to 60°;
  2. Measurement definition: at least 0,02°;
- Software for experimental data analysis and database for comparison of the data pattern. The software shall allow:
  1. Identification of the crystalline phases of the material (search-match);
  2. Quantitative analysis of the diffraction spectrum with phase detection and quantification in accordance with the Rietveld method;
- 40 µm mesh sieve for the selection of the fine fraction of the powder to be analysed.
- Mortar for grinding the binder powder to be analysed.

E.2.2 Test specimens

E.2.2.1 General

The test specimens shall be representative of the product.

E.2.2.2 Preparation of test specimens

A representative spot specimen of (50 ± 1) g of “Natural Binder” shall be grinded and sieved with the 40 µm mesh sieve until all the material will pass the sieve. Then the material shall be mixed to homogenise the powder. The powder can now be used for diffractometric verification.

E.2.3 Experimental procedure

In case of polycrystalline materials, at least two measurements on the same specimen shall be carried out, analysing the diffraction spectra and using the average results of the two or more measurements, in order to obtain a better accuracy of the result.

Instrument and software in conformity to section E.2.1 shall be used to guarantee the precision and reproducibility of the test results.

The characteristics of the instrument and of the analysis method used shall be indicated as required in section E.4 in the test report.

In the analysis phase, the tested "Natural Binder" powder can be considered a polycrystalline material but 100% crystalline. Therefore, software that does not provide methods for calculation of the amorphous phase present in the material can also give quantitatively appreciable and comparable results.

E.3 Expression of results

The result of the instrumental data analysis shall be expressed as mass fraction in percent [%] of C_3A, C_3S and other silicates and aluminates (C_2S, CS, C_4AF).

E.4 Report

The test report shall include at least:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Description of the X-Ray instruments used for test (Theta-Theta opening angle of the goniometer, Measurement definition, X-Ray source, X-ray generator power, X-Ray detector),
g. Description of the software analyser and of the database used for the comparison of the data pattern,
h. Print or image of the data pattern with the expression of test results,
i. Mass fraction in percent [%] of the following phases:
    - C_3A content: **%C_3A** [%],
    - C_3S content: **%C_3S** [%],
    - C_2S content: **%C_2S** [%],
    - CS content: **%CS** [%],
    - C_4AF content: **%C_4AF** [%].

ANNEX F: RESISTANCE TO SULPHATES

F.1 Scope

This Annex specifies a test method to assess the relative resistance of “Natural Binder” to damage caused by the chemical reaction of the material with sulphate salts.

F.2 Principle

After drying to constant mass, the specimen is immerged in a saturated solution of $MgSO_4$ and $(NH_4)_2SO_4$ for 28 days. At the end of the conditioning time the percentage mass change and the percentage compression resistance change are measured.

F.3 Equipment

- A ventilated oven capable of maintaining a temperature of (55 ± 5) °C;
- A weighing instruments capable of weighing the specimens to ± 0,01 g;
- A room or water bath capable of maintaining the temperature of the specimens and solution to (20 ± 1) °C;
- A saturated solution of 50% $MgSO_4$ and 50% $(NH_4)_2SO_4$. The solubility of magnesium sulphate in water at 20°C is greater than 269 g/l. The solubility of ammonium sulphate in water at 20 °C is greater than 754 g/l;
- Instruments for the determination of the compressive strength in accordance with EN 196-1;
- Instruments for the specimen preparation in accordance with EN 459-2, section 7.11.

F.4 Preparation and curing of test specimens

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for at least 24h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm x 40 mm x 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

At least three prism specimens shall be tested.

The specimens shall be cured, stored and conditioned as described in F.7. The mould shall be removed 5 days after preparation of the test specimens.

F.5 Procedure

F.5.1 Drying

Dry the specimens to constant mass in a ventilated oven at a temperature of (55 ± 5) °C. The constant mass is considered to have been reached if two consecutive weighings, 24 hours apart during drying, do not differ by more than 0,2% of the total mass.

Record the dry mass of each specimen ($M_{d,i}$).

F.5.2 Test procedure

The procedure entails to use a saturated solution of magnesium sulphate and ammonium sulphate in water The solution shall be prepared as described in section F3. The saturation of the water shall be checked prior to use, observing the presence of a certain quantity of insoluble residues on the bottom of the container. Check the quantity of insoluble residues at least once a week.

Each of the dried specimens shall be placed in a 250 ml container and covered by the water with dissolved salts to a depth of (8 ± 2) mm above the top of specimen and the container shall be covered to reduce evaporation. Equivalently, the specimens may be placed in a single container provided that there is a minimum space of 10 mm between specimens and at least 20 mm between the specimens and the sides of the container. The specimens shall then be left to soak at (20 ± 1) °C.

NOTE: Changing the soaking temperature can markedly affect the results.

Lift the specimen, stir the solution and immerse the specimen again once a day for up to 28 days to test its integrity.

If failure has occurred or the specimen has fractured during testing, then this shall be recorded together with the number of days of testing (N_{dS}).

After the last day of conditioning the specimens are washed thoroughly with flowing water. The specimens are weighed after drying to constant mass (as in H.5.1) if they are sufficiently coherent.

Record final dry mass of each specimen ($M_{S28,i}$).

Conditioning of the test and reference specimens as indicated in F.7 before proceeding to check the compressive strength of each specimen.

Record the compressive resistance value, as defined in 2.2.2, for both each test ($R_{S28,i}$) and reference ($R_{Sr,i}$) specimen, for the essential characteristic 2.2.14 Sulphate resistance.

F.6 Calculation and value expression

The results shall be expressed:

- As relative mass difference (ΔM_S) [%] (mass loss or gain) as a percentage of the initial dry mass M_d (in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be indicated);
- As relative compression resistance (ΔR_{cS}) [%] (Resistance loss or gain) as a percentage of the resistance of the reference specimens cured as defined in F.7. (R_{Sr}). In case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be indicated;
- As the number of days of exposure (N_{dS}) [n] required to induce failure (in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*no failure of the specimens during the conditioning*" shall be indicated).

Calculate the relative mass difference ($\Delta M_{S,i}$), using the equation (F.6.1):

$$\Delta M_{S,i} = \frac{M_{S28,i} - M_{d,i}}{M_{d,i}} * 100 \text{ [g]} \qquad (F.6.1)$$

$\Delta M_{S,m}$ = mean value of $\Delta M_{S,i}$ for the three specimens.

Calculate the relative compression resistance ($\Delta R_{cS,i}$), using the equation (F.6.2):

$$\Delta R_{cS,i} = \frac{R_{S28,i} - R_{Sr,m}}{R_{Sr,m}} * 100 \text{ [g]} \qquad (F.6.2)$$

$R_{Sr,m}$ = mean value of $R_{Sr,i}$ for the reference specimens.

$\Delta R_{cS,m}$: mean value of $\Delta R_{cS,i}$ for the three specimens.

If failure has occurred or the specimen has fractured during testing, then this shall be recorded together with the number of completed cycles of testing.

A photographic record of the initial and final condition shall be made.

F.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 459-1, keep the mould in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days at (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in in a climatic chamber for 2 days (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 21 days.

Curing of the Reference specimens:

- Cure in air at (21 ± 2°) C and (65 ± 5) $\%_{RH}$ until the 28 days of conditioning for test specimens are completed.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

F.8 Report

The test report shall include at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Analytical method used, detection limits and measurement accuracy,
h. Relative mass difference ($\Delta M_{S,i}$ [g] for each test specimen and $\mathbf{\Delta M_{S,m}}$ [g]),
i. Relative compression resistance ($\Delta R_{cS,i}$ [MPa] for each test specimen and $\mathbf{\Delta R_{cS,m}}$ [MPa]),
j. Number of cycles ($\mathbf{N_{dS}}$ [n]) required to induce failure (if relevant),
k. Photographic record of the initial and final condition of the test specimens,
l. Any deviations from the norm and reasons for such deviations,
m. Note.

ANNEX G: RESISTANCE TO DE-ICING SALTS

G.1 Scope

This Annex specifies a test method to assess the relative resistance of "Natural Binder" to damage caused by the chemical reaction of the material with $CaCl_2$ used as de-icing agent.

G.2 Principle

After drying to constant mass, the specimen is immerged in a saturated solution of $CaCl_2$ for 28 days. At the end of the conditioning time the percentage mass change and the percentage compression resistance change are measured.

G.3 Equipment

- A ventilated oven capable of maintaining a temperature of (55 ± 5) °C;
- A weighing instruments capable of weighing the specimens to ± 0,01 g;
- A room or water bath capable of maintaining the temperature of the specimens and solution to (20 ± 1) °C;
- A saturated solution of calcium chloride. The solubility of calcium chloride in water at 20°C is greater than 720 g/l;
- Instruments for the determination of the compressive strength in accordance with EN 196-1;
- Instruments for the specimen preparation in accordance with EN 459-2, section 7.11.

G.4 Preparation and curing of test specimens

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (55 ± 5) $\%_{RH}$) for at least 24h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms "NHL 5" or "all other types of lime with hydraulic properties", when mentioned in the EN 459-2, shall be considered "Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm x 40 mm x 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms "NHL 5" or "all other types of lime with hydraulic properties", when mentioned in the EN 459-2, shall be considered "Natural Binder".

At least three prism specimens shall be tested.

The specimens shall be cured, stored and conditioned as described in G.7. The mould shall be removed 5 days after preparation of the test specimens.

G.5 Procedure

G.5.1 Drying

Dry the specimens to constant mass in a ventilated oven at a temperature of (55 ± 5) °C. The constant mass is considered to have been reached when two consecutive weighings, 24 hours apart during drying, do not differ by more than 0,2% of the total mass.

Record the dry mass of each specimen ($M_{d,i}$).

G.5.2 Test Procedure

The procedure entails to use a saturated solution of calcium chloride in water. The saturation of the water shall be checked prior to use, observing the presence of a certain quantity of insoluble residues on the bottom of the container. Check the quantity of insoluble residues at least once a week.

Each of the dried specimens shall be placed in a 250 ml container and covered by the water with dissolved salts to a depth of (8 ± 2) mm above the top of specimen and the container shall be covered to reduce evaporation. Equivalently, the specimens may be placed in a single container provided that there is a minimum space of 10 mm between specimens and at least 20 mm between the specimens and the sides of container. The specimens shall then be left to soak at (20 ± 1) °C.

NOTE: Changing the soaking temperature can markedly affect the results.

Lift the specimen and immerse it again once a day for up to 28 days to test its integrity.

If failure has occurred or the specimen has fractured during testing, then this shall be recorded together with the number of days of testing (N_{dD}).

After the last day of conditioning the specimens shall be washed thoroughly with flowing water. The specimens shall be weighed after drying to constant mass (as in G.5.1) if they are sufficiently coherent.

Record final dry mass of each specimen ($M_{D28,i}$).

Conditioning the test and references specimens as indicated in G.7 before proceeding to check the compressive strength of each specimen.

Record the compressive resistance value, as defined in 2.2.2, for both each test ($R_{D28,i}$) and reference ($R_{Dr,i}$) specimen for the essential characteristic 2.2.15 "Resistance to de-icing salts".

G.6 Calculation and value expression

The results shall be expressed:

- As relative mass difference (ΔM_D) [%] (mass loss or gain) as a percentage of the initial dry mass M_d (in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, “*specimens fail during the conditioning*” shall be indicated);
- As relative compression resistance (ΔR_{cD}) [%] (Resistance loss or gain) as a percentage of the resistance of the reference specimens cured as defined in G.7. (R_{Dr}). In case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, “*specimens fail during the conditioning*” shall be indicated;
- As the number of days of exposure (N_{dD}) [n] required to induce failure (in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, “*no failure of the specimens during the conditioning*” shall be indicated).

Calculate the relative mass difference ($\Delta M_{D,i}$), using the equation (G.6.1):

$$\Delta M_{D,i} = \frac{M_{D28,i} - M_{d,i}}{M_{d,i}} * 100 \text{ [g]} \qquad \textit{(G.6.1)}$$

$\Delta M_{D,m}$ = mean value of $\Delta M_{D,i}$ for the three specimens.

Calculate the relative compression resistance ($\Delta R_{cD,i}$), using the equation (G.6.2):

$$\Delta R_{cD,i} = \frac{R_{D28,i} - R_{Dr,m}}{R_{Dr,m}} * 100 \text{ [g]} \qquad \textit{(G.6.2)}$$

$R_{Dr,m}$ = mean value of $R_{Dr,i}$ for the reference specimens.

$\Delta R_{cD,m}$: mean value of $\Delta R_{cD,i}$ for the three specimens.

If failure has occurred or the specimen has fractured during testing, then this shall be recorded together with the number of completed cycles of testing.

A photographic record of the initial and final condition shall be made.

G.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 459-1, keep the mould in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days at (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in in a climatic chamber for 2 days (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 21 days.

Curing of the Reference specimens:

- Cure in air at (21 ± 2°) C and (65 ± 5) $\%_{RH}$ until the 28 days of conditioning for test specimens are completed.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

G.8 Report

The test report shall include at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Analytical method used, detection limits and measurement accuracy,
h. Relative mass difference ($\Delta M_{D,i}$ [g] for each test specimen and **$\Delta M_{D,m}$**[g]),
i. Relative compression resistance ($\Delta R_{cD,i}$ [MPa] for each test specimen and **$\Delta R_{cD,m}$** [MPa]),
j. Number of cycles (**N_{dD}** [n]) required to induce failure (if relevant),
k. Photographic record of the initial and final condition of the test specimens,
l. Any deviations from the norm and reasons for such deviations,
m. Note.

ANNEX H: RESISTANCE TO SEA SALTS

The following procedures are based on the EN 12370.

H.1 Scope

This Annex specifies a test method to assess the relative resistance of “Natural Binder” to damage caused by the crystallization of salts.

H.2 Principle

After drying to constant mass, the specimen is immerged in sea water (or water with salts typical of the sea water in solution), then dried to room temperature. This cycle is carried out 30 times and the percentage mass change and the percentage compression resistance change are measured.

H.3 Equipment

- A ventilated oven capable of maintaining a temperature of (55 ± 5) °C;
- A weighing instruments capable of weighing the specimens to ± 0,01 g;
- A room or water bath capable of maintaining the temperature of the specimens and solution to (20 ± 1) °C;
- Solution of sea salts in water, in such quantity as to reproduce the salinity of real sea water. Marine salts for aquariums can be used in a dosage of about 35 g/l. The density of this solution at 24°C is (1023 ± 3) kg/m^3. The following composition shall be used:

Ca^{++}	Mg^{++}	K^{+}
450 ± 30 ppm	1320 ± 90 ppm	400 ± 30 ppm

Concentration can be checked by mean of Ionic Chromatography or another suitable method (i.e., ICP-OES as described in ISO EN 11885) and adjusted adding calcium and/or magnesium and/or potassium salts to be dissolved in water, when needed, in order to obtain the above concentration.

- Instruments for the determination of the compressive strength in accordance with EN 196-1;
- Instruments for the specimen preparation in accordance with EN 459-2, section 7.11.

H.4 Preparation and curing of test specimens

The product undergoing testing shall be maintained at the standard test conditions (21 ± 2) °C and (55 ± 5) $\%_{RH}$) for at least 24 h before mixing. A mortar mixer in accordance with EN 196-1 shall be used to prepare a batch of product in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

The mixed material shall then be compacted into prism mould with a dimension of 40 mm × 40 mm × 160 mm in accordance with EN 459-2 as specified in section 7.11. The terms “NHL 5” or “all other types of lime with hydraulic properties”, when mentioned in the EN 459-2, shall be considered “Natural Binder".

At least three prism specimens shall be tested.

The specimens shall be cured, stored and conditioned as described in H.7. The mould shall be removed 5 days after preparation of the test specimens.

H.5 Procedure

H.5.1 Drying

Dry the specimens to constant mass in a ventilated oven at a temperature of (55 ± 5) °C. The constant mass is considered to have been reached when two consecutive weighings, 24 hours apart during drying, do not differ by more than 0,2% of the total mass.

Record the dry mass of each specimen ($M_{d,i}$).

H.5.2 Test Procedure

The procedure entails to use a solution of sea salts in water. The density of the sea water shall be checked prior to use. The same sea water shall only be used for one test cycle.

Each of the dried specimens shall be placed in a 250 ml container and covered with the sea water to a depth of (8 ± 2) mm above the top of specimen and the container shall be covered to reduce evaporation. Equivalently, the specimens may be placed in a single container provided that there is a minimum space of 10 mm between specimens and at least 20 mm between the specimens and the sides of container. The specimens shall then be left to soak for 16 h at (20 ± 1) °C.

NOTE: Changing the soaking temperature can markedly affect the results.

After immersion, the specimens shall be removed from the solution and dried in air, in a drying location with controlled environmental conditions (T = (21 ± 1) °C, HR = (50 ± 2) $\%_{HR}$).

Keep the specimens under controlled environmental conditions for 8 h, before resoaking in fresh sea water. The cycle of operation shall be carried out 30 times in all, except when the specimens break up before.

After the last cycle the specimens shall be stored for (24 ± 1) h in water at (21 ± 1) °C, finally, they are washed thoroughly with flowing water. The specimens shall be weighed after drying to constant mass (as in H.5.1) if they are sufficiently coherent. If the test is to be interrupted at any time, the specimens shall be left in air, at (21 ± 1) °C.

Record final dry mass of each specimen ($M_{30,i}$).

Conditioning of the test and reference specimens as indicated in H.7 before proceeding to check the compressive strength of each specimen.

Record the compressive resistance value, as defined in 2.2.2, for both, each test ($R_{30,i}$) and reference ($R_{Wr,i}$) specimens, for the essential characteristic 2.2.16 "Resistance to sea salts".

H.6 Calculation and value expression

The results shall be expressed:

- As relative mass difference (ΔM_W) [%] (mass loss or gain) as a percentage of the initial dry mass M_d (in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be indicated);
- As relative compression resistance (ΔR_{cW}) [%] (Resistance loss or gain) as a percentage of the resistance of the reference specimens cured as defined in H.7. (R_{Wr}) (in case the specimen has disintegrated or has broken into two or more pieces, none of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*specimens fail during the conditioning*" shall be indicated);
- As the number of cycles (N_{cW}) [n] required to induce failure (in case the specimen has not disintegrated or has not broken into two or more pieces, or has broken into two or more pieces of them but one of them representing more than 75% of the specimen, before the final drying, during the conditioning, "*no failure of the specimens during the conditioning*" shall be indicated).

Calculate the relative mass difference ($\Delta M_{W,i}$), using the equation (H.6.1):

$$\Delta M_{W,i} = \frac{M_{30,i} - M_{d,i}}{M_{d,i}} * 100 \text{ [g]} \qquad \text{(H.6.1)}$$

$\Delta M_{W,m}$ = mean value of $\Delta M_{W,i}$ for the three specimens.

Calculate the relative compression resistance ($\Delta R_{cW,i}$), using the equation (H.6.2):

$$\Delta R_{cW,i} = \frac{R_{30,i} - R_{Wr,m}}{M_{d,i}} * 10 \text{ [MPa]} \qquad (H.6.2)$$

$R_{Wr,m}$ = mean value of $R_{Wr,i}$ for the reference specimens.

$\Delta R_{cW,m}$: mean value of $\Delta R_{cW,i}$ for the three specimens.

If failure has occurred or the specimen has fractured during testing, then this shall be recorded together with the number of completed cycles of testing.

A photographic record of the initial and final condition shall be made.

H.7 Summary of temperature and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in EN 459-1, keep the mould in a clear plastic bag to prevent moisture loss, or keep in a climatic chamber for 5 days at (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- De-mould after 5 days and keep in in a climatic chamber for 2 days (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 21 days.

Curing of the Reference specimens:

- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ until the 30 conditioning cycles for test specimens are completed.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests

H.8 Report

The test report shall include at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Analytical method used, detection limits and measurement accuracy,
h. Relative mass difference ($\Delta M_{cw,I}$ [g] for each test specimen and $\boldsymbol{\Delta M_{cw,m}}$ [g]),
i. Relative compression resistance ($\Delta R_{cw,I}$ [MPa] for each test specimen and $\boldsymbol{\Delta R_{cw,m}}$ [MPa]),
j. Number of cycles ($\mathbf{N_{cw}}$ [n]) required to induce failure (if relevant),
k. Photographic record of the initial and final condition of the test specimens,
l. Any deviations from the norm and reasons for such deviations,
m. Note.

ANNEX I: CONTENT OF SOLUBLE SALTS

I.1 Scope

This Annex provides a methodology for the qualitative and quantitative analysis of the anions and cations obtained by dissolving the soluble salts contained in the “Natural Binder”.

The ions considered in this Annex are:

Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, Na^+, K^+, NH_4^+, Ca^{2+}, Mg^{2+}

I.2 Principle

Soluble salts are extracted from a pulverized solid subspecimen by dissolving in a fixed volume of ultrapure water. The content of soluble salts in the specimen can be determined by conductivity measurement and qualitative and quantitative ion analysis after filtration.

I.3 Equipment

The equipment is described in the section 5 of EN 16455.

I.4 Preparation and curing of test specimens

The test specimen shall be prepared using a (50,0 ±0,5) g specimen of “Natural Binder”, mixed with water according to the following indications:

- Water/binder ratio 0,40,
- Use of neat binder paste,
- Use of deionized water.

The paste shall be maintained at the standard test conditions as described in I.7.

I.5 Procedure

The analysis procedures are based on the EN 16455, section 6.2. Anions shall be determined in accordance with EN ISO 10304-1 and cations shall be determined in accordance with EN ISO 11885.

I.6 Calculation and value expression

The expression of specific conductivity γ shall be in in accordance with section 7.1 of EN 16455.

γ_7 is the specific conductivity value obtained from the test of the “Natural Binder” paste after 7 days of ageing.

γ_{28} is the specific conductivity value obtained from the test of the “Natural Binder” paste after 28 days of ageing.

The expression of the results of the ion analysis shall be done for Ca^{2+}, Mg^{2+}, K^+, Na^+, SO_4^{2-}, Cl^-. For each cation or anion, express the percentage of dry mass of the specimen (I_i%) in accordance with section 7.2 of EN 16455.

I.7 Summary of temperatures and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in I.3, cover in film, or keep in a climatic chamber for (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 2 and 23 days.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

I.8 Report

The test report shall include at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Analytical method used, detection limits and measurement accuracy,
h. Specific conductivity after 7 days aging (γ_7[µS/cm]) and after 28 days aging (γ_{28} [µS/cm]),
i. Percentage of dry mass of the specimen (**I_i%**) for Ca^{2+}, Mg^{2+}, K^+, Na^+, SO_4^{2-}, Cl^- ions,
j. Any deviations from the norm and reasons for such deviations,
k. Note.

ANNEX J: HEAT OF HYDRATION

The following procedures are based on the EN 196-8.

J.1 Scope

This standard describes a method for determining the heat of hydration of the “Natural Binder” by means of solution calorimetry, also known as the solution method. The heat of hydration is expressed in joules per gram of binder.

J.2 Principle

The method, based on the EN 196-8, consists in measuring the heat of solution, in an acid mixture, of anhydrous “Natural Binder” and the same binder hydrated under standardized conditions below for 7 days and 28 days.

The heat of hydration for each period, H_7 and H_{28}, is obtained from the difference between the heat of solution of anhydrous “Natural Binder”, Q_a and that of hydrated binder, Q_7 and Q_{28}.

J.3 Equipment

Use equipment according with EN 196-8, section 4 and section 5.

J.4 Preparation and curing of test specimens

The test specimen shall be prepared using a (100,0 ± 0,1) g specimen of “Natural Binder”, mixed with water according to the following indications:

- Water/binder ratio 0,40,
- Use of neat binder paste,
- Use of deionized water.

The paste shall be maintained at the standard test conditions as described in L.7.

J.5 Procedure

Provide to the calorimeter calibration according with EN 196-8, section 6.

The analysis procedures are based on the EN 196-8, section 7.

J.6 Calculation and value expression

Calculate the heat of hydration of “Natural Binder”, H_7 and H_{28}, expressed in joules per gram [J/g] and referenced to 20°C, as the difference between the heat of solution of anhydrous and hydrated “Natural Binder”, obtained in accordance with 7.1.2 and 7.2.3 of EN 196-8 from equations (J.6.1) and (J.6.2):

$$H_7 = Q_a - Q_7 \quad [\text{J/g}] \qquad \textit{(J.6.1)}$$

$$H_{28} = Q_a - Q_{28} \quad [\text{J/g}] \qquad \textit{(J.6.2)}$$

Where

Q_a = heat of solution of the anhydrous “Natural Binder”, expressed in joules per gram of hydrated binder.

Q_7 = heat of solution, expressed in joules per gram [J/g], of the “Natural Binder” after 7 days of hydration.

Q_{28} = heat of solution, expressed in joules per gram [J/g], of the “Natural Binder” after 28 days of hydration.

J.7 Summary of temperatures and humidity for the curing, conditioning, and testing of the product

Curing:

- Prepare as indicated in J.3, cover in film, or keep in a climatic chamber for (21 ± 2) °C and (95 ± 5) $\%_{RH}$.
- Cure in air at (21 ± 2) °C and (65 ± 5) $\%_{RH}$ for 2 and 23 days.

Conditioning and Testing:

- Take from the curing/storage environment and condition in standard laboratory climate at (21 ± 2) °C and (55 ± 5) $\%_{RH}$ for 30 min before using them for tests.

J.8 Report

The test report shall include at least the following information:

a. Reference to this test method,
b. Name and address of the test laboratory,
c. Identification number and date of test,
d. Product name, factory, manufacturer, or supplier,
e. Production code number or similar identifier of the product,
f. Method of preparation of the specimens, and details of any curing process, where necessary,
g. Analytical method used, detection limits and measurement accuracy,
h. Heat of hydration after 7 days ($\mathbf{H_7}$ [J/g]) and after 28 days aging ($\mathbf{H_{28}}$ [J/g]),
i. Any deviations from the norm and reasons for such deviations,
j. Note.