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**ETA 17/0908
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General part

Technical Assessment Body issuing the ETA: ITeC	
ITeC has been designated according to Article 29 of Regulation (EU) No 305/2011 and is member of EOTA (European Organisation for Technical Assessment)	
Trade name of the construction product	Pozzolanica Solena
Product family to which the construction product belongs	26 – Products related to concrete, mortar and grout.
Manufacturer	SOLENA s.r.l. Via C. Cattaneo 62 IT-23900 Lecco Italy
Manufacturing plant(s)	Via Strada Statale dei Giovi 80 Paderno Dugnano IT-20037 Milano Italy
This European Technical Assessment contains	14 pages
This European Technical Assessment is issued in accordance with Regulation (EU) 305/2011, on the basis of	European Assessment Document 260009-00-0301 <i>Processed bottom ash from municipal solid waste incinerators as type II addition for production of concrete, mortar and grout.</i>
This version replaces	ETA 17/0908 of 19.12.2017

General comments

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

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Specific parts of the European Technical Assessment

1 Technical description of the product

Pozzolanica Solena is a type II addition obtained by physical and chemical treatment of municipal solid waste incinerators bottom ashes (MIBA) deriving from municipal solid waste incinerators (waste from households as well as commercial, industrial and institutional waste which, because of its nature and composition, is similar to waste from households, excluding hazardous waste).

The treatment process is characterized by wet micronization of the mineral particles, by the high level reached of separation of metal scraps initially present in MIBA and, particularly, by the fact that the final product is metallic aluminium free and therefore does no longer induce hydrogen formation¹.

The final product (which, after wet micronization in form of slurry, undergoes a partial dehydration phase) is a humid aggregate with sand appearance and a grain size about 0 mm to 6 mm, constituted of elemental fine particles aggregated in clusters. The water present in the product should be considered as hydration water in concrete design.

The product is normally used in combination with a plasticizer and/or superplasticizer and, in particular conditions, depending on the other components of concrete, the mix design, etc., it may require an addition of a defoamer² in order to avoid the entrapment of excess of air. The granulate form may require an additional mixing time to disperse the particles.

The product is registered under REACH and its EC number is 939-997-0.

Concerning product packaging, transport, and storage, it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport and storage, of the product as he 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.

2 Specification of the intended use(s) in accordance with the applicable EAD

Pozzolanica Solena is intended for use as type II addition for concrete, including cast-in-situ or prefabricated structural concrete conforming to European standard EN-206. It may also be used in mortars and grouts.

Pozzolanica Solena is intended to be used in combination with Portland cement (CEM I) and Portland-composite cements (CEM II/A) with the percentages indicated in annex A. Assessed exposure classes are indicated in annex B.

3 Performance of the product and reference to the methods used for its assessment

Performances of the Pozzolanica Solena type II addition, related to the basic requirements for construction works (hereinafter BWR), were determined according to EAD 260009-00-0301 *Processed bottom ash from municipal solid waste incinerators as type II addition for production of concrete, mortar and grout*. Essential characteristics of Pozzolanica Solena are included in table 3.1.

¹ Hydrogen formation may cause problems of expansion on fresh concrete, this is a well-known phenomenon of MIBA.

² The product is normally added with a certain quantity of defoamer at the production site. However, in some concretes, depending mostly on superplasticizer and also on mix design and the other constituents (cement, aggregates, etc.), it is necessary to add additional quantities of defoamer.

Basic Works Requirement	Essential characteristic	Performance			
BWR 1 Mechanical resistance and stability		SiO ₂ + Al ₂ O ₃ + Fe ₂ O ₃	53,55 %		
	Composition ⁽¹⁾	Total sulphates (SO ₃) (≤ 3 %)	0,57 %		
		Total chlorides (Cl ⁻)	0,15 %		
		Water soluble chlorides (Cl ⁻)	0,09 %		
		Total phosphates (P ₂ O ₅) (≤ 5 %)	1,21 %		
		Activity index ⁽²⁾	At 28 days (≥ 75 %)	90,5 %	
	At 90 days (≥ 85 %)		92,4 %		
	Fineness	By wet sieving (≤ 12,0 % by mass)	1,6 %		
		By laser diffraction	D(v;0,5) = 6,45 μm		
	Soundness ⁽³⁾	Reference mortar	- 0,99 %		
		Assessed mortar	- 0,74 %		
	Moisture content ⁽¹⁾		20,8 %		
	Loss on ignition ⁽¹⁾		5,3 %		
	Particle density		2.631 kg/m ³		
	Initial setting time		Initial setting time	Final setting time	Limit of setting time
		Reference mortar	2 h 20 min	3 h 15 min	--
Assessed mortar		2 h 30 min	3 h 30 min	≤ 4 h 40 min	
Compressive strength		See annex A			
Depth of penetration of water under pressure		See annex B1			
Relative carbonation resistance		See annex B2			
Chloride diffusion resistance		See annex B3			
Sulphate resistance		See annex B4			

Notes:

- (1) Percentage by mass.
- (2) Percentage between the compressive resistance of the assessed mortar and the reference mortar.
- (3) Percentage of change in height of the assessed mortar and the reference mortar related to their initial values.

Table 3.1: Performance of Pozzolanica Solena.

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

According to the Decision 1999/469/EC amended by Decision 2001/596/EC, as amended of the European Commission³, the system of AVCP (see EC delegated regulation (EU) No 568/2014 amending Annex V to Regulation (EU) 305/2011) given in the following table applies:

Product	Intended use	System
Pozzolanica Solena	Addition type II for concrete, mortar and grout	1+

Table 4.1: Applicable AVCP System.

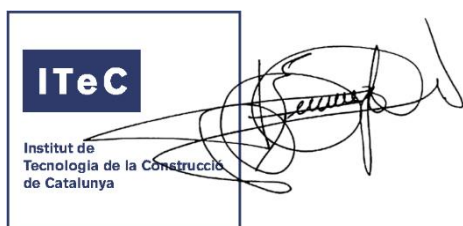
5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

All the necessary technical details for the implementation of the AVCP system are laid down in the *Control Plan* deposited with the ITeC⁴, with which the factory production control shall be in accordance.

Any change in the manufacturing procedure which may affect the properties of the product shall be notified and the necessary type-testing revised according to the *Control Plan*.

Issued in Barcelona on 24 May 2018

by the Catalonia Institute of Construction Technology.



Ferran Bermejo Nualart
Technical Director, ITeC

³ Official Journal of the European Union (OJEU) L184/27 of 25/06/1999.
Official Journal of the European Union (OJEU) L209/33 of 02/08/2011.

⁴ The *Control Plan* is a confidential part of the ETA and is only handed over to the notified certification body involved in the assessment and verification of constancy of performance.

ANNEX A: COMPRESSION STRENGTH AND K VALUE

Cement	Age (days)	Water / cement (ω_a) ⁽¹⁾	k function of ω_r	Minimum k value
60 % CEM I 52.5R + 40 % Pozzolanica Solena	7	0,40	$\frac{-0,267}{\omega_r} + 0,988$	0,32
		0,50		0,45
		0,60		0,54
	28	0,40	$\frac{-0,471}{\omega_r} + 1,429$	0,25
		0,50		0,49
		0,60		0,64
	90	0,40	$\frac{-0,223}{\omega_r} + 1,158$	0,60
		0,50		0,71
		0,60		0,79
80 % CEM I 52.5R + 20 % Pozzolanica Solena	7	0,40	$\frac{0,109}{\omega_r} + 0,696$	0,97
		0,50		0,91
		0,60		0,88
	28	0,40	$\frac{0,247}{\omega_r} + 0,457$	1,08
		0,50		0,95
		0,60		0,87
	90	0,40	$\frac{-0,318}{\omega_r} + 1,638$	0,84
		0,50		1,00
		0,60		1,11
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	7	0,40	$\frac{-0,633}{\omega_r} + 1,776$	0,20
		0,50		0,52
		0,60		0,73
	28	0,40	$\frac{-0,227}{\omega_r} + 1,137$	0,57
		0,50		0,68
		0,60		0,76
	90	0,40	$\frac{-0,200}{\omega_r} + 1,127$	0,63
		0,50		0,73
		0,60		0,79
85 % CEM II/A-LL 42.5R + 15 % Pozzolanica Solena	7	0,40	$\frac{-0,787}{\omega_r} + 2,340$	0,37
		0,50		0,77
		0,60		1,03
	28	0,40	$\frac{0,322}{\omega_r} + 0,446$	1,25
		0,50		1,09
		0,60		0,98
	90	0,40	$\frac{0,145}{\omega_r} + 0,744$	1,11
		0,50		1,03
		0,60		0,99

Notes:

⁽¹⁾ The water / cement ratio of the assessed mortar (ω_a) is the same water / cement ratio as the reference mortar (ω_r).

Table A1: k values.

ANNEX B: EQUIVALENT DURABILITY

Test scheme for the assessment of equivalent durability:

Cements involved in the assessment		Exposure class
Reference	Assessment	
CEM II/A-LL 42.5R	70 % CEM II/A-LL 42.5R	XC4 + XD3 + XS3
CEM IV/A (V) 42.5R ⁽¹⁾	+ 30% Pozzolanica Solena	XC4 + XD3 + XS3 + XA3

Notes:

- ⁽¹⁾ The reference and the assessment cement are not the same when assessing the exposure class XA3. CEM IV/A (V) 42.5R is needed to assess the exposure classes XC4 + XD3 + XS3 + XA3. It has not technical sense to use CEM IV/A 42.5R + 40% Pozzolanica Solena as assessment cement, because of the high percentage of Pozzolanica Solena in this cement, and also because the ETA holder does not want to add Pozzolanica Solena to the CEM IV.

Table B0: Test scheme for the assessment of equivalent durability.

ANNEX B1: DEPTH OF PENETRATION OF WATER UNDER PRESSURE

Concrete	Water / cement ratio	Depth of penetration (max./mean) of water under pressure (EN 12390-8) [mm]			
		Specimen			Mean value
		1	2	3	
100 % CEM IV 42.5R	$\omega_1 = 0,43$	17 / 8	17 / 9	17 / 9	17 / 9
	$\omega_2 = 0,45$	18 / 11	19 / 12	18 / 11	18 / 11
	$\omega_3 = 0,47$	19 / 11	20 / 12	19 / 11	19 / 11
100 % CEM II/A-LL 42.5R	$\omega_1 = 0,43$	9 / 6	9 / 6	12 / 8	10 / 7
	$\omega_2 = 0,45$	11 / 8	10 / 9	13 / 10	11 / 9
	$\omega_3 = 0,47$	16 / 9	15 / 8	15 / 9	15 / 9
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	$\omega_1 = 0,38$	12 / 7	10 / 7	14 / 9	12 / 8
	$\omega_2 = 0,40$	15 / 10	15 / 9	14 / 9	15 / 9
	$\omega_3 = 0,41$	16 / 10	17 / 10	16 / 9	16 / 10

Table B1: Depth of penetration of water under pressure.

ANNEX B2: RELATIVE CARBONATION RESISTANCE

The relative carbonation resistance after 186, 273 and 365 days are displayed in tables B2.1, B2.2 and B2.3, respectively. The evolution of the carbonation depth over time is displayed in table B2.4. It is foreseen to continue the test and to take measurements at 547 and 730 ($\pm 2\%$) days.

Concrete	Water / cement ratio	Carbonation depth (d_k) (CEN/TS 12390-10) [mm]						
		After 186 days						Mean values
		Specimen	Face of specimen				Mean values	
A	B		C	D				
100 % CEM IV 42.5R	$\omega_1 = 0,43$	1A	1,8	1,9	1,9	4,0 ⁽¹⁾	1,9	1,8
		1B	1,6	1,6	1,5	1,9	1,7	
	$\omega_2 = 0,45$	4A	2,3	2,3	2,7	2,5	2,5	2,3
		4B	2,3	2,4	2,3	1,5	2,1	
	$\omega_3 = 0,47$	7A	2,5	3,7	2,5	2,5	2,8	2,8
		7B	3,0	2,2	2,7	3,2	2,8	
100 % CEM II/A-LL 42.5R	$\omega_1 = 0,43$	2A	1,5	2,5	2,2	2,6	2,2	2,2
		2B	2,5	1,9	1,5	2,7	2,2	
	$\omega_2 = 0,45$	5A	2,8	2,8	2,7	2,9	2,8	2,8
		5B	2,5	2,8	2,2	3,4	2,7	
	$\omega_3 = 0,47$	8A	3,5	2,6	2,5	3,5	3,0	3,0
		8B	3,8	1,2	3,8	2,7	2,9	
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	$\omega_1 = 0,38$	3A	2,5	2,3	2,5	2,9	2,6	2,6
		3B	2,5	3,2	2,5	2,7	2,7	
	$\omega_2 = 0,40$	6A	1,3	3,5	1,1	3,7	2,4	2,7
		6B	2,7	3,7	2,0	3,4	3,0	
	$\omega_3 = 0,41$	9A	2,5	2,5	2,5	3,0	2,6	3,0
		9B	3,5	3,5	3,2	3,5	3,4	

Notes:

- (1) According to CEN/TS 12390-10, values of penetration of CO₂ for which the measured values of Δd_k are greater than or equal to 4 mm shall not be included when calculating the mean carbonation depth. See figure 2 of CEN/TS 12390-10 for the meaning of Δd_k .

Table B2.1: Carbonation depth at 186 days.

Concrete	Water / cement ratio	Carbonation depth (d_k) (CEN/TS 12390-10) [mm]						
		After 273 days						Mean values
		Specimen	Face of specimen				Mean values	
A	B		C	D				
100 % CEM IV 42.5R	$\omega_1 = 0,43$	1A	1,7	0,7	2,4	1,7	1,6	1,8
		1B	1,2	1,9	1,8	2,6	1,9	
	$\omega_2 = 0,45$	4A	7,7 ⁽¹⁾	2,0	3,1	1,6	2,2	2,4
		4B	4,3	2,0	1,9	2,0	2,6	
	$\omega_3 = 0,47$	7A	3,8	3,6	3,2	4,1	3,7	3,5
		7B	2,9	3,2	3,4	3,6	3,3	

Concrete	Water / cement ratio	Carbonation depth (d_k) (CEN/TS 12390-10) [mm]						
		After 273 days						
		Specimen	Face of specimen				Mean values	
A	B		C	D				
100 % CEM II/A- LL 42.5R	$\omega_1 = 0,43$	2A	2,5	2,3	2,1	1,6	2,1	2,3
		2B	2,9	2,5	2,9	2,0	2,6	
	$\omega_2 = 0,45$	5A	6,0 ⁽¹⁾	3,9	2,9	2,7	3,2	3,1
		5B	2,4	4,1	3,8	2,1	3,1	
	$\omega_3 = 0,47$	8A	4,0	4,3	3,2	4,7	4,1	3,7
		8B	3,4	3,4	3,3	3,3	3,4	
70 % CEM II/A- LL 42.5R + 30 % Pozzolanica Solena	$\omega_1 = 0,378$	3A	3,3	3,4	3,0	2,3	3,0	2,9
		3B	3,3	2,7	2,6	2,6	2,8	
	$\omega_2 = 0,396$	6A	3,2	3,8	2,6	3,0	3,1	3,2
		6B	2,8	3,4	3,3	3,9	3,3	
	$\omega_3 = 0,414$	9A	4,4	4,3	3,6	3,1	3,9	3,7
		9B	3,7	4,2	3,9	2,8	3,6	

Notes:

- (1) According to CEN/TS 12390-10, values of penetration of CO₂ for which the measured values of Δd_k are greater than or equal to 4 mm shall not be included when calculating the mean carbonation depth. See figure 2 of CEN/TS 12390-10 for the meaning of Δd_k .

Table B2.2. Carbonation depth at 273 days.

Concrete	Water / cement ratio	Carbonation depth (d_k) (CEN/TS 12390-10) [mm]						
		After 365 days						
		Specimen	Face of specimen				Mean values	
A	B		C	D				
100 % CEM IV 42.5R	$\omega_1 = 0,43$	1A	1,8	1,2	2,6	1,5	1,8	1,8
		1B	1,4	2,5	1,4	1,6	1,7	
	$\omega_2 = 0,45$	4A	3,0	4,0	2,6	4,5	3,5	3,1
		4B	2,8	3,5	1,8	2,7	2,7	
	$\omega_3 = 0,47$	7A	3,4	4,2	3,6	3,2	3,6	3,5
		7B	3,2	3,3	3,3	3,5	3,3	
100 % CEM II/A- LL 42.5R	$\omega_1 = 0,43$	2A	3,6	3,9	2,5	2,9	3,2	2,9
		2B	2,5	2,0	3,3	2,6	2,6	
	$\omega_2 = 0,45$	5A	3,5	3,2	3,9	2,9	3,4	3,2
		5B	2,8	3,2	3,2	2,5	2,9	
	$\omega_3 = 0,47$	8A	3,3	4,3	4,2	4,8	4,2	4,3
		8B	4,0	4,9	4,1	4,9	4,5	
70 % CEM II/A- LL 42.5R + 30 % Pozzolanica Solena	$\omega_1 = 0,378$	3A	3,4	3,4	3,0	3,6	3,3	3,3
		3B	3,5	2,3	3,5	3,7	3,3	
	$\omega_2 = 0,396$	6A	3,8	2,3	4,1	3,3	3,4	3,3
		6B	3,0	3,6	2,6	3,2	3,1	

Concrete	Water / cement ratio	Carbonation depth (d_k) (CEN/TS 12390-10) [mm]					Mean values
		After 365 days					
		Specimen	Face of specimen				
A	B		C	D			
	$\omega_3 = 0,414$	9A	4,6	5,1	4,8	4,4	4,5
		9B	4,0	5,0	5,3	3,0	

Table B2.3. Carbonation depth at 365 days.

Concrete	Water / cement ratio	Carbonation depth (mean value) (d_{km}) [mm] according to the exposure time in days				
		186	273	365	457	730
100 % CEM IV 42.5R	0,43	1,8	1,8	1,8	--	--
100 % CEM II/A-LL 42.5R	0,43	2,2	2,3	2,9	--	--
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	0,378	2,6	2,9	3,3	--	--
100 % CEM IV 42.5R	0,45	2,3	2,4	3,1	--	--
100 % CEM II/A-LL 42.5R	0,45	2,8	3,1	3,2	--	--
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	0,396	2,7	3,2	3,3	--	--
100 % CEM IV 42.5R	0,47	2,8	3,5	3,5	--	--
100 % CEM II/A-LL 42.5R	0,47	3,0	3,7	4,3	--	--
70 % CEM II/A-LL 42.5R + 30 % Pozzolanica Solena	0,414	3,0	3,7	4,5	--	--

Table B2.4: Evolution of the carbonation depth over time.

ANNEX B3: CHLORIDE DIFFUSION RESISTANCE

Concrete	Water / cement ratio	Chloride penetration with left-right edge colorimetric measurement (EN 12390-11) [mm]						Mean value
		Specimen	Measurement point					
			1	2	3	4	5	
100 % CEM IV 42.5R	$\omega_1 = 0,43$	1A'	17	12	10	10	10	12
	$\omega_2 = 0,45$	4A'	15	10	14	16	22	15
	$\omega_3 = 0,47$	7A'	17	25	11	18	18	18
100 % CEM II/A- LL 42.5R	$\omega_1 = 0,43$	2A'	12	20	13	17	19	16
	$\omega_2 = 0,45$	5A'	9	10	10	17	15	12
	$\omega_3 = 0,47$	8A'	19	18	15	23	19	19
70 % CEM II/A- LL 42.5R + 30 % Pozzolonica Solena	$\omega_1 = 0,38$	3A'	8	10	10	6	6	8
	$\omega_2 = 0,40$	6A'	5	10	15	3	5	8
	$\omega_3 = 0,41$	9A'	8	15	8	7	7	9

Table B3.1: Chloride penetration.

Specimen	Reference level in potable water	Content of chloride [%] in the concrete							
		At the depth [mm] of:							
		0 – 3	3 – 6	6 – 9	9 – 12	12 – 15	15 – 18	18 – 21	21 – 24
1A'	< 0,010	0,643	0,380	0,240	0,129	0,065	< 0,058	< 0,029	0
4A'	< 0,011	0,463	0,283	0,143	0,082	0,041	0,026	0,018	0
7A'	0,016	0,343	0,233	0,167	0,084	0,033	0,037	0,018	0
2A'	< 0,010	0,567	0,333	0,213	0,167	0,098	0,048	0,024	0
5A'	0,016	0,370	0,270	0,207	0,120	0,072	0,034	< 0,029	0
8A'	0,012	0,390	0,257	0,210	0,133	0,051	0,036	0,014	0
3A'	0,014	0,370	0,213	0,101	0,055	< 0,033	0	0	0
6A'	0,012	0,273	0,180	0,093	0,038	0,022	0	0	0
9A'	0,012	0,260	0,157	0,097	0,042	0,021	0	0	0

Notes:

- *Extrapolated values in italics.*

Table B3.2: Quantitative profile of chloride penetration.

ANNEX B4: SULPHATE RESISTANCE

4,4 % Na₂SO₄ solution at 20 °C (sulphate storage at 20 °C)							
Assessed characteristics (mean value of 3 specimens) for CEM IV/A (V) 42.5R ($\omega_2 = 0,45$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	12,24	40,10	160,04	--	166,3	2.139	29.178
14	12,15	40,04	160,17	0,812	166,4	2.149	32.408
28	12,24	40,13	160,10	0,375	167,5	2.147	33.265
56	12,06	40,18	160,12	0,500	168,4	2.194	35.359
90	12,13	40,07	160,08	0,250	168,3	2.187	37.589
180	12,16	40,01	159,96	-0,500	168,5	2.185	38.066

Assessed characteristics (mean value of 3 specimens) for 70 % CEM II/A-LL 42.5R + 30% Pozzolanica Solena ($\omega_2 = 0,396$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	15,42	39,92	160,19	--	217,0	2.203	31.021
14	15,37	39,99	160,44	1,560	216,2	2.196	33.427
28	15,38	39,96	160,34	0,936	217,1	2.205	34.867
56	15,38	39,90	160,18	-0,062	217,5	2.217	36.108
90	15,29	39,94	160,32	0,812	217,7	2.228	38.366
180	15,29	39,99	160,20	0,062	217,6	2.224	40.194

Table B4.1: Sulphate resistance assessment (sulphate storage at 20 °C).

4,4 % Na₂SO₄ solution at 5 °C (sulphate storage at 5°C).							
Assessed characteristics (mean value of 3 specimens) for CEM IV/A (V) 42.5R ($\omega_2 = 0,45$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	13,49	40,15	160,10	--	172,6	1.978	25.402
14	13,43	40,17	160,01	-0,562	172,4	1.985	26.295
28	13,44	40,19	160,07	-0,187	173,5	1.994	28.378
56	13,11	40,12	160,16	0,375	174,7	2.062	29.975
90	13,11	40,15	160,33	1,437	174,6	2.055	30.661
180	14,26 ⁽¹⁾	40,28 ⁽¹⁾	160,33 ⁽¹⁾	1,437	194,5 ⁽¹⁾	2.102 ⁽¹⁾	31.766 ⁽¹⁾

⁽¹⁾ One of the three specimens broke during the last period.

Assessed characteristics (mean value of 3 specimens) for 70 % CEM II/A-LL 42.5R + 30% Pozzolanica Solena ($\omega_2 = 0,396$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	12,82	40,19	159,96	--	181,3	2.191	31.797
14	12,67	40,07	160,00	0,250	180,6	2.221	34.052
28	12,79	40,06	160,10	0,875	181,4	2.210	35.166
56	12,42	40,04	159,94	-0,125	182,1	2.296	37.465
90	12,52	40,12	159,90	-0,375	181,9	2.263	37.902
180	12,63	40,17	159,60	-2,250	182,0	2.245	39.773

Table B4.2: Sulphate resistance assessment (sulphate storage at 5°C).

Saturated Ca(OH) ₂ solution at 20 °C (reference storage at 20 °C).							
Assessed characteristics (mean value of 3 specimens) for CEM IV/A (V) 42.5R ($\omega_2 = 0,45$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	13,29	39,92	160,14	--	179,8	2.127	27.491
14	12,95	40,14	160,13	-0,062	179,2	2.162	29.261
28	13,12	39,94	160,41	1,686	180,6	2.160	31.037
56	13,12	39,88	160,19	0,312	180,7	2.165	32.487
90	13,04	39,96	160,18	0,250	181,4	2.185	34.529
180	12,99	39,95	160,13	-0,063	181,4	2.196	35.691

Assessed characteristics (mean value of 3 specimens) for 70 % CEM II/A-LL 42.5R + 30% Pozzolanica Solena ($\omega_2 = 0,396$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	10,95	40,05	159,92	--	162,2	2.326	35.118
14	10,93	40,18	160,09	1,063	163,3	2.323	35.520
28	10,98	40,03	159,96	0,250	163,9	2.331	37.771
56	10,92	40,04	159,99	0,438	164,4	2.350	39.254
90	10,87	40,01	159,98	0,375	164,0	2.356	41.108
180	10,88	40,09	160,03	0,688	164,2	2.351	41.825

Table B4.3: Sulphate resistance assessment (reference storage at 20 °C).

Saturated Ca(OH)₂ solution at 5 °C (reference storage at 5 °C).							
Assessed characteristics (mean value of 3 specimens) for CEM IV/A (V) 42.5R ($\omega_2 = 0,45$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	11,71	39,84	159,45	--	157,6	2.118	23.354
14	11,69	39,94	160,09	4,014	158,1	2.115	25.072
28	11,72	39,97	160,10	4,077	159,3	2.126	25.326
56	11,82	39,94	160,00	3,449	160,2	2.121	26.444
90	11,76	39,57	160,01	3,512	160,7	2.158	27.476
180	11,71	39,95	160,06	3,826	160,6	2.145	28.173
Assessed characteristics (mean value of 3 specimens) for 70 % CEM II/A-LL 42.5R + 30% Pozzolanica Solena ($\omega_2 = 0,396$)							
Age of specimens [days]	Dimensions (height, width and length) [mm]			Expansion of the length (ΔL) [mm/m]	Weight [g]	Density (D) (EN 12390-7) [kg/m ³]	Elastic modulus $E_d = D \cdot V^2 \cdot 0,83$ (EN 12504-1) [N/mm ²]
0	12,02	39,85	160,38	--	162,7	2.132	26.963
14	11,95	39,99	160,14	-1,497	163,3	2.148	28.661
28	11,93	39,85	160,29	-0,561	164,5	2.171	30.226
56	11,90	39,87	160,30	-0,499	165,8	2.190	31.239
90	11,86	39,75	160,35	-0,187	165,8	2.207	31.795
180	11,98	39,89	160,29	-0,561	166,3	2.182	33.451

Table B4.4: Sulphate resistance assessment (reference storage at 5 °C).