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and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-17/0826
of 22 November 2017

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Product family
to which the construction product belongs

Blast furnace cement CEM III/A with assessment of
sulfate resistance and optional with low effective alkali
content (LA) and/or low heat of hydration (LH)

Manufacturer

Spenner GmbH & Co. KG
Bahnhofstraße 20
59597 Erwitte
DEUTSCHLAND

Manufacturing plant

Spenner GmbH & Co. KG
Werk Duisburg
Am Röhrenwerk 52
47259 Duisburg
DEUTSCHLAND

This European Technical Assessment
contains

15 pages including 10 annexes which form an integral
part of this assessment

This European Technical Assessment is
issued in accordance with Regulation (EU)
No 305/2011, on the basis of

EAD 150009-00-0301

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Specific Part

1 Technical description of the product

The blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" is a cement which fulfils all requirements given in EN 197-1¹ for a common cement of strength class 52,5 N.

Furthermore the blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" has a high resistance against sulfate attack on concrete (SR) and a low effective alkali content (LA).

The assessment for the verification of the essential characteristic "sulfate resistance" (SR) and "low effective alkali content" (LA) was done on a blast furnace cement CEM III/A with a blast furnace slag² content of 45 % by mass and a specific surface of the cement² of 520 m²/kg (C1) respectively 530 m²/kg (C2).

The low effective alkali content (LA) can be verified by the Na₂O-equivalent (Na₂O_{eq}) and the blast furnace slag content of the blast furnace cement CEM III/A:

- Blast furnace slag content between 45 to 49 % by mass and Na₂O_{eq} ≤ 0,95 % by mass or
- Blast furnace slag content of ≥ 50 % by mass and Na₂O_{eq} ≤ 1,10 % by mass

The blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" is manufactured from a pre-cement³, a by-pass dust up to 0,5 % by mass and a blast furnace slag² under addition of gypsum or anhydrite or any mixture of them to control setting by separately grinding of the raw materials and subsequent mixing with a specific surface (Blaine) of at least 530 m²/kg with following cement composition:

Portland cement clinker:	35 to 52 % by mass
Blast furnace slag ² :	48 to 65 % by mass

2 Specification of the intended use in accordance with the applicable European Assessment Document

The blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" is intended to be used for preparation of concrete, mortar, grouts and other mixes for construction and for the manufacturing of construction products.

Especially the blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" is characterized by an evidently high resistance against sulfate attack on concrete.

The blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" can be used to avoid a damaging alkali-silica reaction in concrete.

The verification and assessment methods on which the European Technical Assessment is based lead to the assumption of a working life of concrete incorporating the blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

¹ EN 197-1 Cement - Part 1: Composition, specification and conformity criteria for common cement
² The assessment testing were done on two blast furnace cement CEM III/A 52,5 N-SR/LA (CEM III/A 52,5 N (C1) and CEM III/A 52,5 N (C2)). The blast furnace cement C1 was manufactured with blast furnace slag 1 (S1) and blast furnace cement C2 with blast furnace slag 2 (S2). The assessment testing of the two test cements were positive. In this case it is possible to manufacture the blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" with a blast furnace slag composition of blast furnace slags (S1) and (S2).
³ The pre-cement is a Portland cement CEM I 52,5 R that does not contain any minor additional constituents.

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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
(CaO + MgO)/SiO ₂ -ratio of the blast furnace slag	B _{S1} = 1,2 B _{S2} = 1,3
Glass content of the blast furnace slag	GC _{S1} = 100 % GC _{S2} = 100 %
Specific surface of the cement (Blaine)	ρ _{C1} = 520 m ² /kg ρ _{C2} = 530 m ² /kg
Sulfate resistance	see Annex A (A1 to A4)
Characteristics for a common cement (CEM III/A)	
Early strength (2 days)	Class N (≥ 20,0 N/mm ²)
Standard strength (28 days)	Class 52,5 (≥ 52,5 N/mm ²)
Initial setting time	C1: Passed (190 min) C2: Passed (180 min)
Soundness	C1: Passed (0 mm) C2: Passed (1 mm)
Loss on ignition	C1: Passed (0,59 % by mass) C2: Passed (0,46 % by mass)
Insoluble residue	C1: Passed (0,12 % by mass) C2: Passed (0,28 % by mass)
Sulfate content (as SO ₃)	C1: Passed (3,51 % by mass) C2: Passed (3,34 % by mass)
Chloride content	C1: Passed (0,03 % by mass) C2: Passed (0,05 % by mass)
<u>Composition of the cement (C1):</u> Clinker (K): Blast furnace slag (S1): <u>Composition of the cement (C2):</u> Clinker (K): Blast furnace slag (S2):	<u>CEM III/A (C1):</u> K = 55 % by mass (35 – 55 % by mass) S1 = 45 % by mass (45 – 65 % by mass) <u>CEM III/A (C2):</u> K = 55 % by mass (35 – 55 % by mass) S2 = 45 % by mass (45 – 65 % by mass)
Alkali-Content of the cement Na ₂ O-equivalent	CEM III/A (C1): 0,64 % by mass CEM III/A (C2): 0,55 % by mass
S1: Blast furnace slag 1 S2: Blast furnace slag 2	C1: Blast furnace cement with blast furnace slag 1 C2: Blast furnace cement with blast furnace slag 2

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

According to Decision 97/555/EC⁴ of the European Commission amended by the Commission Decision 2010/683/EU⁵, the assessment and verification of constancy of performance system (AVCP system) (see Annex V to Regulation (EU) 305/2011 as amended by the Commission Delegated Regulation (EU) No 568/2014) given in table 1 applies.

Table 1: AVCP system

Product	Intended use(s)	Level(s) or Classe(s) of performance	AVCP system
Blast furnace cement CEM III/A with assessment of sulfate resistance (SR) and optional with low effective alkali content (LA) and/or low heat of hydration (LH)	Preparation of concrete, mortar, grouts and other mixes for construction and for the manufacture of construction products	-----	1+

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 22 November 2017 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Schröder

⁴ Official Journal of the European Communities L 229 of 20 August 1997
⁵ Official Journal of the European Communities L 293 of 11 November 2010

Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 1: Expansion of length of mortar flat prisms – Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

	Expansion of length [mm/m] after				
	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 20 °C					
Na ₂ SO ₄ -solution	0,07	0,16	0,23	0,29	0,55
Ca(OH) ₂ -solution	0,01	0,03	0,05	0,06	0,12
ΔL	0,06	0,13	0,18	0,23	0,43
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 5 °C					
Na ₂ SO ₄ -solution	-0,07	-0,08	0,08	0,31	-
Ca(OH) ₂ -solution	-0,16	-0,19	-0,04	-0,05	-
ΔL	0,09	0,11	0,12	0,36	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C					
Na ₂ SO ₄ -solution	0,08	0,15	0,17	0,23	0,26
Ca(OH) ₂ -solution	0,07	0,05	0,10	0,16	0,11
ΔL	0,01	0,10	0,07	0,07	0,15
CEM III/B 42,5 N-LH/SR – storage at 5 °C					
Na ₂ SO ₄ -solution	0,00	0,08	0,09	0,24	-
Ca(OH) ₂ -solution	-0,11	-0,04	-0,04	0,05	-
ΔL	0,11	0,12	0,13	0,19	-
CEM I 42,5 R-SR3 – storage at 20 °C					
Na ₂ SO ₄ -solution	0,14	0,17	0,26	0,38	0,65
Ca(OH) ₂ -solution	0,09	0,09	0,12	0,16	0,09
ΔL	0,05	0,08	0,14	0,22	0,56
CEM I 42,5 R-SR3 – storage at 5 °C					
Na ₂ SO ₄ -solution	-0,09	0,02	0,08	0,43	-
Ca(OH) ₂ -solution	-0,13	-0,11	-0,06	-0,02	-
ΔL	0,04	0,13	0,14	0,45	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Expansion of length – Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 2: Expansion of length of mortar flat prisms – Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

	Expansion of length [mm/m] after				
	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 20 °C					
Na ₂ SO ₄ -solution	0,06	0,13	0,12	0,24	0,31
Ca(OH) ₂ -solution	0,03	0,10	0,00	0,07	0,01
ΔL	0,03	0,03	0,12	0,17	0,30
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 5 °C					
Na ₂ SO ₄ -solution	-0,10	-0,04	0,16	0,40	-
Ca(OH) ₂ -solution	-0,13	-0,14	-0,15	-0,09	-
ΔL	0,03	0,10	0,31	0,49	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C					
Na ₂ SO ₄ -solution	0,02	0,10	0,05	0,13	0,14
Ca(OH) ₂ -solution	0,01	0,08	0,03	0,08	0,04
ΔL	0,01	0,02	0,02	0,05	0,10
CEM III/B 42,5 N-LH/SR – storage at 5 °C					
Na ₂ SO ₄ -solution	-0,13	-0,11	-0,11	-0,11	-
Ca(OH) ₂ -solution	-0,13	-0,12	-0,16	-0,16	-
ΔL	0,00	0,01	0,05	0,05	-
CEM I 42,5 R-SR3 – storage at 20 °C					
Na ₂ SO ₄ -solution	0,06	0,14	0,20	0,42	0,93
Ca(OH) ₂ -solution	0,02	0,02	-0,03	0,09	-0,09
ΔL	0,04	0,12	0,23	0,33	1,02
CEM I 42,5 R-SR3 – storage at 5 °C					
Na ₂ SO ₄ -solution	-0,04	-0,05	-0,01	0,10	-
Ca(OH) ₂ -solution	-0,07	-0,12	-0,11	-0,06	-
ΔL	0,03	0,07	0,10	0,16	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Expansion of length – Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 3: Dynamic modulus of elasticity of mortar flat prisms - Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

	Dynamic modulus of elasticity in kN/mm ² after					
	0 days	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 20 °C						
Ca(OH) ₂ -solution	28,5	30,8	33,3	35,0	36,3	38,4
Na ₂ SO ₄ -solution	29,4	34,4	35,9	36,2	36,7	37,2
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 5 °C						
Ca(OH) ₂ -solution	29,3	30,3	30,9	31,6	32,4	-
Na ₂ SO ₄ -solution	29,5	33,3	34,8	35,1	34,7	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C						
Ca(OH) ₂ -solution	28,7	30,9	32,8	34,8	36,5	38,1
Na ₂ SO ₄ -solution	28,5	30,9	31,6	32,6	32,6	32,1
CEM III/B 42,5 N-LH/SR – storage at 5 °C						
Ca(OH) ₂ -solution	29,0	29,7	30,0	30,7	31,6	-
Na ₂ SO ₄ -solution	28,5	30,9	31,6	32,6	32,6	-
CEM I 42,5 R-SR3 – storage at 20 °C						
Ca(OH) ₂ -solution	35,8	36,4	36,9	37,9	38,6	38,9
Na ₂ SO ₄ -solution	35,3	37,4	38,2	39,1	39,6	39,8
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	35,3	36,2	36,4	36,9	37,5	-
Na ₂ SO ₄ -solution	36,2	37,8	38,3	38,7	38,6	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Dynamic modulus of elasticity - Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 4: Dynamic modulus of elasticity of mortar flat prisms - Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

	Dynamic modulus of elasticity in kN/mm ² after					
	0 days	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 20 °C						
Ca(OH) ₂ -solution	30,5	32,7	34,9	37,5	39,6	41,0
Na ₂ SO ₄ -solution	31,1	37,1	38,2	38,5	37,7	37,6
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 5 °C						
Ca(OH) ₂ -solution	29,4	30,6	31,0	32,0	32,7	-
Na ₂ SO ₄ -solution	29,1	33,0	34,1	34,7	33,8	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C						
Ca(OH) ₂ -solution	33,7	36,6	37,8	40,0	39,3	39,9
Na ₂ SO ₄ -solution	33,7	37,3	37,6	37,0	35,7	35,3
CEM III/B 42,5 N-LH/SR – storage at 5 °C						
Ca(OH) ₂ -solution	33,0	33,8	34,1	34,6	35,3	-
Na ₂ SO ₄ -solution	33,0	34,3	35,1	35,4	35,2	-
CEM I 42,5 R-SR3 – storage at 20 °C						
Ca(OH) ₂ -solution	36,7	37,7	38,0	38,2	38,6	37,8
Na ₂ SO ₄ -solution	36,3	38,3	38,7	39,2	40,2	40,6
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	37,0	37,2	37,9	37,2	37,2	-
Na ₂ SO ₄ -solution	36,5	37,7	37,8	38,0	38,3	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Dynamic modulus of elasticity - Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 5: Mass of mortar flat prisms - Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

	Mass in g after					
	0 days	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 20 °C						
Ca(OH) ₂ -solution	144,0	114,4	145,0	145,3	144,8	145,2
Na ₂ SO ₄ -solution	144,3	144,6	145,0	145,4	145,5	146,8
CEM III/A 52,5 N-SR/LA "Duisburg" (C1 with blast furnace slag 1 (S1)) – storage at 5 °C						
Ca(OH) ₂ -solution	146,1	146,6	146,8	146,6	146,8	-
Na ₂ SO ₄ -solution	145,9	146,3	146,5	146,6	147,0	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C						
Ca(OH) ₂ -solution	144,9	145,4	145,4	145,6	145,8	146,0
Na ₂ SO ₄ -solution	145,0	145,4	145,8	145,8	146,3	147,3
CEM III/B 42,5 N-LH/SR – storage at 5 °C						
Ca(OH) ₂ -solution	145,8	146,3	146,3	146,9	146,4	-
Na ₂ SO ₄ -solution	146,0	146,4	146,4	146,5	146,7	-
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	147,7	148,2	148,3	148,6	148,7	148,6
Na ₂ SO ₄ -solution	147,1	147,4	147,7	147,9	148,5	149,0
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	147,6	148,2	148,3	148,6	149,1	-
Na ₂ SO ₄ -solution	146,8	147,5	147,5	147,8	148,0	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Mass of the mortar flat prisms – Blast furnace cement 1 (C1) with blast furnace slag 1 (S1)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

Table 6: Mass of mortar flat prisms - Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

	Mass in g after					
	0 days	14 days	28 days	56 days	90 days	180 days
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 20 °C						
Ca(OH) ₂ -solution	174,1	147,3	147,5	147,6	147,6	148,0
Na ₂ SO ₄ -solution	147,4	147,8	148,2	149,1	149,7	150,6
CEM III/A 52,5 N-SR/LA "Duisburg" (C2 with blast furnace slag 2 (S2)) – storage at 5 °C						
Ca(OH) ₂ -solution	143,9	144,2	144,5	144,8	144,8	-
Na ₂ SO ₄ -solution	143,4	143,8	144,0	144,5	145,1	-
CEM III/B 42,5 N-LH/SR – storage at 20 °C						
Ca(OH) ₂ -solution	147,7	147,5	147,4	147,4	147,6	147,8
Na ₂ SO ₄ -solution	147,8	147,6	147,7	147,8	148,5	149,1
CEM III/B 42,5 N-LH/SR – storage at 5 °C						
Ca(OH) ₂ -solution	145,5	145,4	145,4	145,5	145,4	-
Na ₂ SO ₄ -solution	144,9	145,1	145,1	145,3	145,3	-
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	147,5	147,6	147,5	147,7	147,7	147,6
Na ₂ SO ₄ -solution	147,2	147,2	147,2	147,5	147,7	148,2
CEM I 42,5 R-SR3 – storage at 5 °C						
Ca(OH) ₂ -solution	146,4	146,4	146,7	146,9	147,5	-
Na ₂ SO ₄ -solution	147,0	146,9	147,1	147,5	148,1	-

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (Flat prism method) – S_{FPM} "
Mass of the mortar flat prisms – Blast furnace cement 2 (C2) with blast furnace slag 2 (S2)

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Testing of Sulfate Resistance of Blast-furnace cement CEM III/A – Flat prism method S_{FPM}

The testing procedure was done according to EAD 150009-00-0301, Annex B.

After a testing period of 180 days the specimens show no expansion damages, cracks or flaking based on formation of thaumasite, see figures 1 to 8.



Figure 1: Specimens with CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 1 (S1) after 180 days; Storage: 20 °C in Na_2O_4 -Solution



Figure 2: Specimens with CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 1 (S1) after 180 days; Storage: 5 °C in Na_2O_4 -Solution

Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (flat prism method) – S_{FPM} "
Visual examination of the flat prisms with blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 1 (S1)

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Figure 3: Specimens with CEM III/B 42,5 N-LH/SR after 180 days;
Storage: in Na_2O_4 -Solution at 20 °C (on the left) and at 5 °C (on the right)

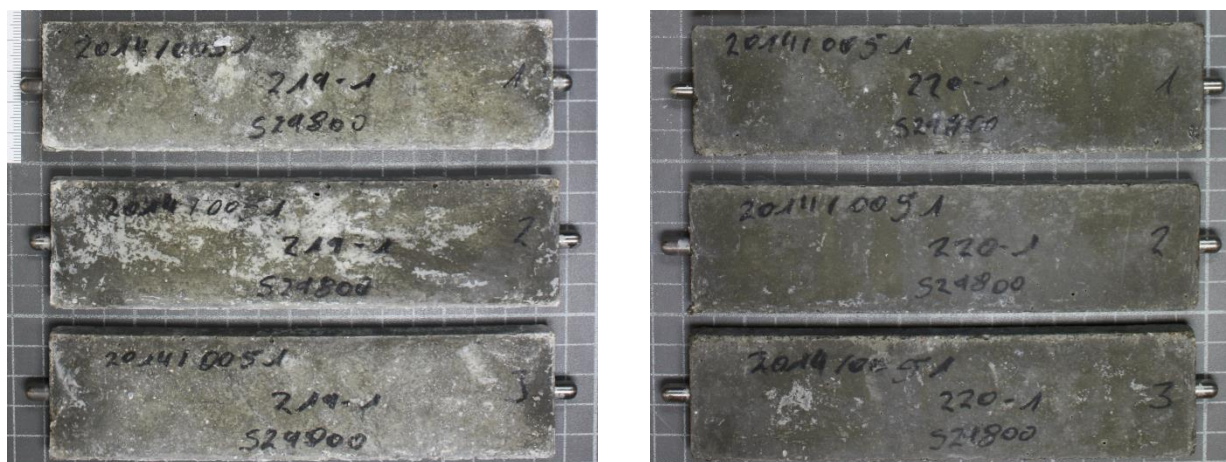


Figure 4: Specimens with CEM I 42,5 R-SR3 after 180 days;
Storage: in Na_2O_4 -Solution at 20 °C (on the left) and at 5 °C (on the right)

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Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (flat prism method) – S_{FPM} "
Visual examination of the flat prisms with CEM III/B 42,5 N-LH/SR and with CEM I 42,5 R-SR3

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Figure 5: Specimens with CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 2 (S2) after 180 days; Storage: 20 °C in Na₂O₄-Solution



Figure 6: Specimens with CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 2 (S2) after 180 days; Storage: 5 °C in Na₂O₄-Solution

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Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (flat prism method) – S_{FPM}"
Visual examination of the flat prisms with blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg" with blast furnace slag 2 (S2)

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Figure 7: Specimens with CEM III/B 42,5 N-LH/SR after 180 days;
Storage: in Na₂O₄-Solution at 20 °C (on the left) and at 5 °C (on the right)



Figure 8: Specimens with CEM I 42,5 R-SR3 after 180 days;
Storage: in Na₂O₄-Solution at 20 °C (on the left) and at 5 °C (on the right)

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Blast furnace cement CEM III/A 52,5 N-SR/LA "Duisburg"

Results of the assessment "sulfate resistance (flat prism method) – S_{FPM}"
Visual examination of the flat prisms with CEM III/B 42,5 N-LH/SR and with CEM I 42,5 R-SR3

Annex A4
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