Test Report

Spacers extruded fibre concrete

PB 1.1/15-068-1 | 21.01.2016 | english

Testing of delivered spacers made of extruded fibre concrete

Tested by: MFPA Leipzig GmbH, Leipzig

Recognized Testing Laboratory by the VMPA
Concrete Testing VMPA-B-2003

MFPA Leipzig GmbH
Testing, Inspection and Certification Authority for
Construction Products and Construction Types

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Test Report No. PB 1.1/15-068-1

21 January 2016
No. Copy 1

Subject matter:	Testing of delivered spacers made of extruded fibre concrete Grade No. 83
Client:	Max Frank GmbH & Co. KG Mitterweg 1 94339 Leiblfing
Date of order:	07/10/2015
Client's reference:	Mr. Lindner
Samples received on:	07/10/2015
Sampling:	Client
Identification:	Grade No. 83
Date of testing:	October 2015 to January 2016
Person in charge:	Dipl.-Ing. M. Becker Dr. rer. nat. J. Schneider

This document consists of 8 pages and - appendices.

DAkkS Deutsche Akkreditierungsstelle D-PL-11021-01-00

Testing laboratory accredited by DAkkS GmbH according to DIN EN ISO/IEC 17025. The accreditation only applies to the test methods listed in the certificate (in this document marked with *) which can be seen on www.mfpa-leipzig.de

Notified testing laboratories, inspection bodies and certification bodies recognized according to the Construction Products Law (NB 800) and the State Building Code (SAC 02).

Gesellschaft für Materialforschung und Prüfungsanstalt für das Bauwesen Leipzig mbH (MFPA Leipzig GmbH)

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1 Preliminary remarks

Spacers of extruded fibre concrete were delivered for testing on 7 October .2015. The following tests were carried out in accordance with the order:

- Testing the compressive strength
- Testing the capillary water absorption
- Testing the water absorption
- Determining the resistance to penetration by chloride ions
- Determining the chloride diffusion coefficients

2 Test results

2.1 Compressive strength

Text pieces of the size (50 mm x 50 mm x 50 mm) were handed over for testing. The edges of the test pieces were rounded. The rounded edges were not taken into account when calculating the test surfaces. The compressive strength was tested in accordance with DIN EN 12390-3 [1]. After delivery until testing, the test specimens were stored according to DIN EN 12390-2 [2], [3], in standard atmosphere at 20 °C and 65 % relative humidity. The results are summarised in Table 1.

Table 1: Compressive strength

Samples no.	Dimensions			Volume	Mass	Bulk density	Area	Breaking force	Pressure resistance[1]
	Length l [mm]	Width w [mm]	Height h [mm]	V [cm³]	m_f [g]	ρ_{2f} [kg/m³]	A_c [mm²]	F_{dry} [kN]	$f_{c,dry}$ [N/mm²]
1	50.3	50.1	49.9	125.7	280.9	2230	2520	248.6	98.6
2	50.1	50.4	49.9	126.0	282.2	2240	2525	261.5	103.6
3	50.3	50.1	49.8	125.5	280.9	2240	2520	248.1	98.5
					Mean value:	**2240**			**100.2**

Notes: [1] Date of manufacture: 8 September 2015
Date of testing: 13 October 2015
Age of sample: 35 days

2.2 Water absorption

2.2.1 Capillary water absorption / water absorption coefficient

Text pieces of the size (100 mm x 50 mm x 50 mm) were handed over for testing. After delivery until the start of testing, the samples were stored in standard atmosphere at 20 °C and 65% relative humidity. The capillary water absorption was determined in accordance with DIN EN 15148 [4]. The lateral areas were sealed with paraffin. The results are summarised in Tables 2 and 3.

Table 2: Capillary water absorption

Time	1 1)		2 2)		3 3)	
t [min]	m_t [kg]	Δm_t [kg/m²]	m_t [kg]	Δm_t [kg/m²]	m_t [kg]	Δm_t [kg/m²]
0	0.5721	-	0.5705	-	0.5740	-
5	0.5722	0.0198	0.5705	0.0000	0.5741	0.0198
10	0.5723	0.0395	0.5705	0.0000	0.5742	0.0396
30	0.5723	0.0395	0.5706	0.0200	0.5742	0.0396
60	0.5723	0.0395	0.5706	0.0200	0.5742	0.0396
120	0.5724	0.0593	0.5706	0.0200	0.5743	0.0594
240	0.5725	0.0791	0.5707	0.0399	0.5743	0.0594
360	0.5725	0.0791	0.5707	0.0399	0.5744	0.0792
480	0.5726	0.0988	0.5707	0.0399	0.5745	0.0990
1440	0.5729	0.1581	0.5710	0.0998	0.5748	0.1584

Notes: 1) Test area - test piece 1: 0.00506 m²

2) Test area - test piece 2: 0.00501 m²

3) Test area - test piece 3: 0.00505 m²

Table 3: Water absorption coefficient after 24 h

Time t [h]	1 W_w [kg/m² · h^0,5]	2 W_w [kg/m² · h^0,5]	3 W_w [kg/m² · h^0,5]	Mean water absorption coefficient [kg/m² · h^0,5]
24	0.03	0.02	0.03	0.03

2.2.2 Maximum water absorption / water absorption coefficient

Text pieces of the size (100 mm x 50 mm x 50 mm) were handed over for testing. After delivery until the start of testing, the samples were stored in standard atmosphere at 20 °C and 65% relative humidity. The maximum water absorption was determined at atmospheric pressure in compliance with DIN EN ISO 15148 [4]. In derogation from the test specification, the samples were stored completely under water. The results are summarised in Tables 4 and 5.

Table 4: Maximum water absorption

Time	4[1)]		5[2)]		6[3)]	
t [min]	m_t [kg]	Δm_t [kg/m²]	m_t [kg]	Δm_t [kg/m²]	m_t [kg]	Δm_t [kg/m²]
0	0.5548	0.0000	0.5570	0.0000	0.5597	0.0000
5	0.5548	0.0000	0.5571	0.0039	0.5597	0.0000
10	0.5548	0.0000	0.5571	0.0039	0.5597	0.0000
30	0.5549	0.0040	0.5572	0.0079	0.5598	0.0040
60	0.5551	0.0119	0.5572	0.0079	0.5600	0.0119
120	0.5551	0.0119	0.5572	0.0079	0.5600	0.0119
240	0.5551	0.0119	0.5573	0.0118	0.5602	0.0198
360	0.5552	0.0158	0.5574	0.0158	0.5603	0.0238
480	0.5552	0.0158	0.5578	0.0315	0.5604	0.0278
1440	0.5556	0.0317	0.5580	0.0394	0.5606	0.0357

Notes: [1)] Test area - test piece 4: 0.02525 m²
[2)] Test area - test piece 5: 0.02539 m²
[3)] Test area - test piece 6: 0.02521 m²

Table 5: Water absorption coefficient after 24 h

Time t [h]	4 W_w [kg/m² · h^{0,5}]	5 W_w [kg/m² · h^{0,5}]	6 W_w [kg/m² · h^{0,5}]	Mean water absorption coefficient [kg/m² · h^{0,5}]
24	0.006	0.008	0.007	**0.007**

2.3 Resistance to penetration by chloride ions

The resistance to penetration was tested on three samples in accordance with ASTM C 1202 [5]. To this end, the samples were sawn out of concrete cylinders with a diameter of (98 ± 1) mm and a thickness of d = (50 ± 1) mm).

Before determining the resistance to penetration, the samples were saturated in a desiccator by means of a vacuum and installation in the test cell. The current strength I was measured every 30 min. at a voltage U of 60 V over a test period of 6 h. Equation 1 /1/ shows the charge Q that was conducted through the sample in C (Coulomb).

$$Q = 900(I_0 + 2I_{30} + 2I_{60} + \ldots + 2I_{300} + 2I_{330} + I_{360}) \quad \text{(Eq. 1)}$$

with: Q – Charge in Coulomb
I_0 – Current strength in amperes at the start
I_t – Current strength in amperes at time t (in min)

The resistance to penetration was classified in accordance with [5] on the basis of the calculated charge Q, as shown in Table 6.

Table 6: Classification of permeability for chloride ions

Q in C	Permeability for chloride
> 4000	high
2000 – 4000	moderate
1000 – 2000	low
100 – 1000	very low
< 100	negligible

The measured values and the resulting charge Q calculated from these to assess the resistance to penetration are summarised in Table 7.

Table 7: Measured values to determine the permeability for chloride ions

Parameter	Test piece no. 83.1	Test piece no. 83.2	Test piece no. 83.3
I_0 in mA	21.8	21.7	20.6
I_{30} in mA	24.2	24.1	23.1
I_{60} in mA	24.4	24.5	23.2
I_{90} in mA	24.9	24.6	23.3
I_{120} in mA	24.9	24.6	23.3
I_{150} in mA	25.0	24.7	23.4
I_{180} in mA	24.8	24.6	23.4
I_{210} in mA	24.9	24.7	23.4
I_{240} in mA	24.9	24.6	23.4
I_{270} in mA	24.8	24.6	23.4
I_{300} in mA	24.9	24.7	23.5
I_{330} in mA	25.0	24.6	23.5
I_{360} in mA	25.0	24.7	23.5
Q in C	533.0	528.3	502.1
Classification Q in C	**521 (very low)**		

2.4 Chloride diffusion coefficient acc. to NT Build 443 [6]

The chloride diffusion coefficient was determined in accordance with NT Build 443 [6]. To this end, 3 concrete cylinders were produced and delivered by the client.

The concrete cylinders were saturated with $Ca(OH)_2$ solution up to a constant weight. The shell surfaces and the side of the cylinder that was not to be exposed to testing were then sealed with a cohesive layer of epoxy resin. After the resin had hardened, the samples were stored for 35 days at (23 ± 2)°C in a sodium chloride solution with a concentration of (165 ± 1) g NaCl/dm^3. After storage, the concrete cylinders were milled off millimetre for millimetre using a milling machine and the chloride content in the grinding dust determined in accordance with the DAfStb Guideline "Chloride in concrete" [7]. The total chloride contents in M.-%, relative to the initial weight of the concrete sample, are summarised in Table 8 as a function of the sampling depth. The chloride concentration that was determined is shown as a function of the depth in Figure 1.

Table 8: Chloride concentration in M.-% as a function of the sampling depth

Sampling depth [mm]	Test piece no. 83.1 m_{Cl} [M.-%]	Test piece no. 83.2 m_{Cl} [M.-%]	Test piece no. 83.3 m_{Cl} [M.-%]
0 to 1	1.313	1.261	1.300
1 to 2	1.088	1.113	1.120
2 to 3	0.775	0.682	0.690
3 to 4	0.320	0.358	0.360
4 to 5	0.161	0.185	0.193
5 to 6	0.126	0.117	0.113
6 to 7	0.101	0.085	0.078
7 to 8	0.092	0.076	0.070
Reference sample[1)]	0.051	0.052	0.052

Notes: [1)] without exposure to chloride

The diffusion coefficient was calculated in accordance with [6] from the regression analysis. For the formulation 83, this is $D_e = 0.43 \cdot 10^{-12}$ m²/s.

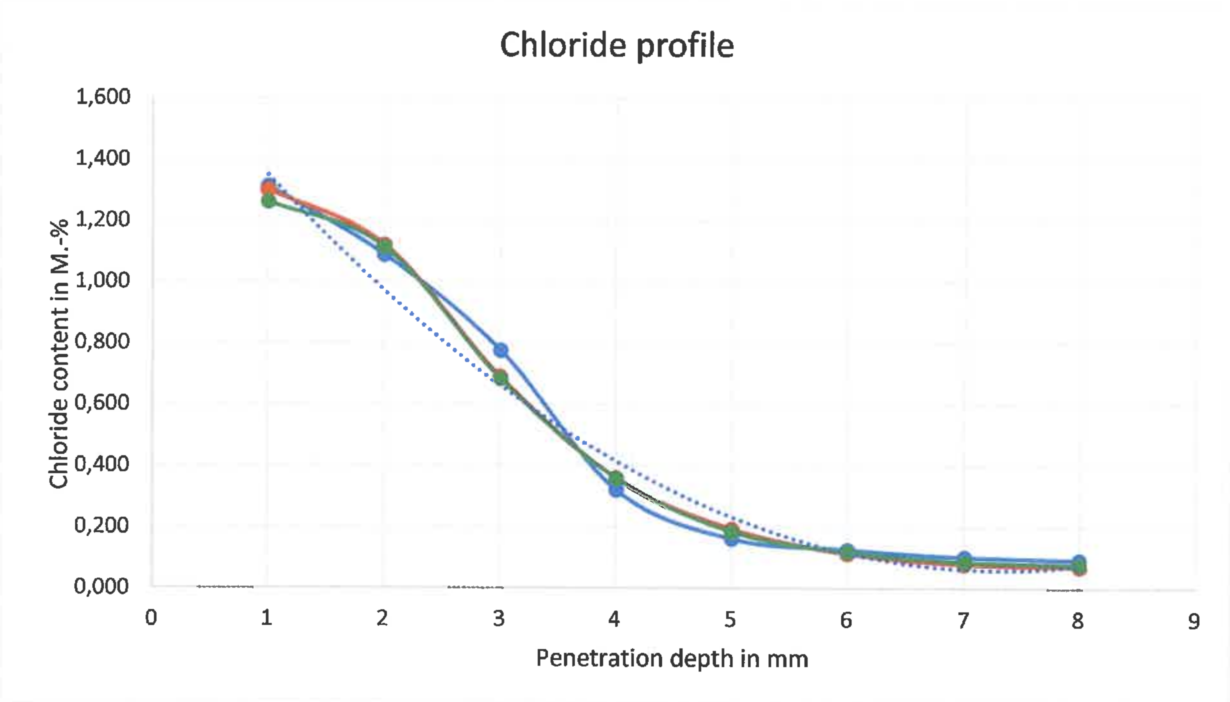

Figure 1: Chloride profile formulation 83 after 35d in NaCl solution

3 References

[1] DIN EN 12390-3 "Testing hardened concrete – part 3: Compressive strength of test specimens"; Version 07/2009

[2] DIN 12390-2 "Testing hardened concrete – part 2: Making and curing specimens for strength tests"; Version 08/2009

[3] DIN 12390-2 Corrigendum 1 "Testing hardened concrete – part 2: Making and curing specimens for strength tests"; Version 02/2012

[4] DIN EN ISO 15148 "Hygrothermal performance of building materials and products - Determination of water absorption coefficient by partial immersion"; Version 03/2003

[5] ASTM C 1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration, 2012

[6] NT BUILD 443, Concrete, Hardened: Accelerated Chloride Penetration, 1995-11

[7] Deutscher Ausschuss für Stahlbeton (DAfStb): Arbeitskreis "Prüfverfahren Chlorideindringtiefe" Beuth Verlag, No. 401, 1989

The results of the tests exclusively refer to the described test objects but not to the main unit. This document does not replace a certificate of conformity or suitability according to national and European building codes.

Leipzig, 21 January 2016

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