Test Report
No. 07-036-e

Fachhochschule Augsburg
University of Applied Sciences

Laboratory for Building Materials at the
University of Applied Sciences, Augsburg

Subject:

Tests on cementitious screeds

Ordering party:

Alexander Unger
c/o UNGER Thermo-Boden GmbH
Friedrich-Kanzler-Str. 1
D-85716 München-Unterschleißheim

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responsible for the content

Prof. Dipl.-Ing. Manfred Schnell

PROF. DIPL.-ING. MANFRED SCHNELL
Von der Industrie- und Handelskammer für Augsburg und Schwaben für Schäden an Fußbodenkonstruktionen (Fliesen- und Plattenbeläge, Beschichtungen, mineralische Estriche, Abdichtungen im Verbund), Materialprüfung bauchemischer Produkte tätig
öffentl. best. u. vereid. Sachverständiger

Prof. Manfred Schnell
schnell@fh-augsburg.de

Labor für Baustofftechnologie
an der FH Augsburg
fon +49 821 5586-129
fax +49 821 5586-126
www.kki-augsburg.de

Fachhochschule Augsburg
University of Applied Sciences
Baumgartnerstraße 16
D 86161 Augsburg

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1. Introduction

The Laboratory for Building Materials at the University of Applied Sciences, Augsburg, was ordered by Mr Alexander Unger (ordering party, below referred to as "op") to conduct experiments with mortars for floating screeds, based on a novel formulation.

The experiments are to determine the material behaviour of the tested screeds in relation to a comparison mixture (usual screed mixture used at building lots).

The experimental set-up, the test procedure and the manufacture of sample areas were discussed with the "op" and were realized according to valid international test standards.

The experiments were conducted by Mr Tobias Keller, graduate engineer, in the period between 29 June 2007 and 24 October 2007.

2. Test procedure

All in all, six screeds were installed within two settings (2 plus 4) as floating load-bearing layers. The details are shown in the following illustrations and tables:

Series	Area no.	Mixture	Date of installation	Bottom section [mm]	Thickness [mm]	Nature	Dimension [m]
1	1	*RenoScreed*	04.07.07	20	35	Unheated	2.70 x 3.60
1	2	Comparison mixture	04.07.07	20	35	Unheated	2.70 x 3.60
2	1	*RenoScreed*	13.08.07	20	35	Heated	1.35 x 1.80
2	2	*RenoScreed*	13.08.07	20	55	Unheated	1.35 x 1.80
2	3	Comparison mixture	13.08.07	20	45	Heated	1.35 x 1.80
2	4	Comparison mixture	13.08.07	20	65	Unheated	1.35 x 1.80

Table 1: Overview of the sample areas.

The following illustrations give an overview of the position of the sample areas in the basement of the laboratory of building materials at the University of Applied Sciences Augsburg (Temperature: 11 – 18°C; 65 – 90 % rel. humidity).

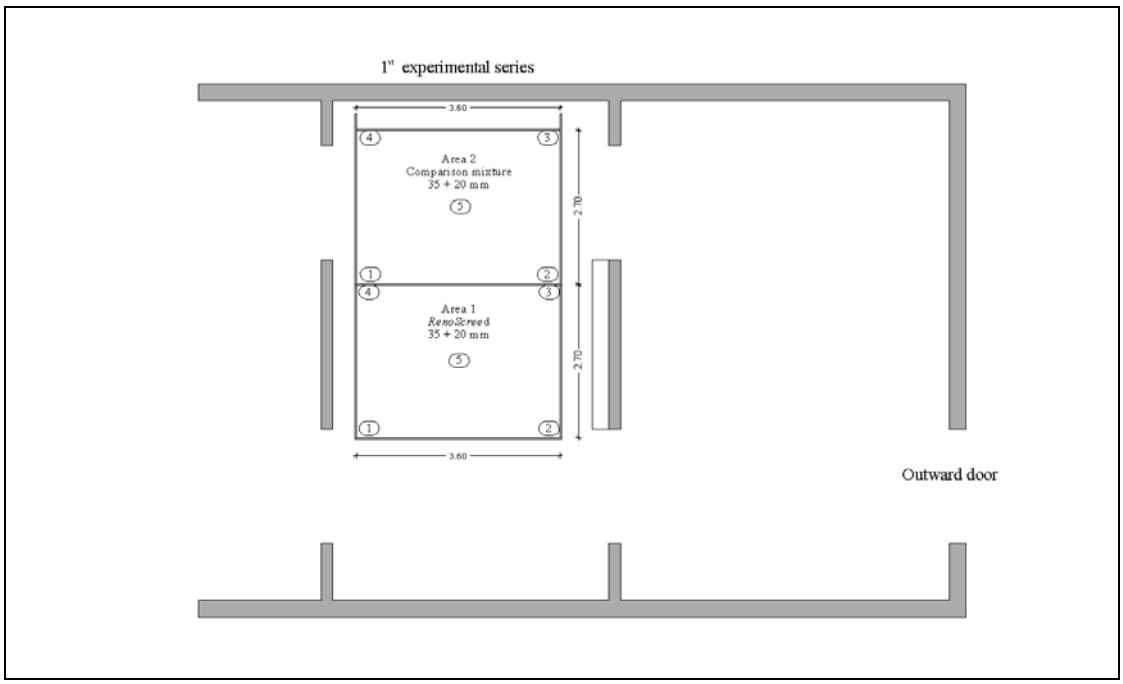


Illustration 1: Overview of the installed sample areas, 1st experimental series (=ES).

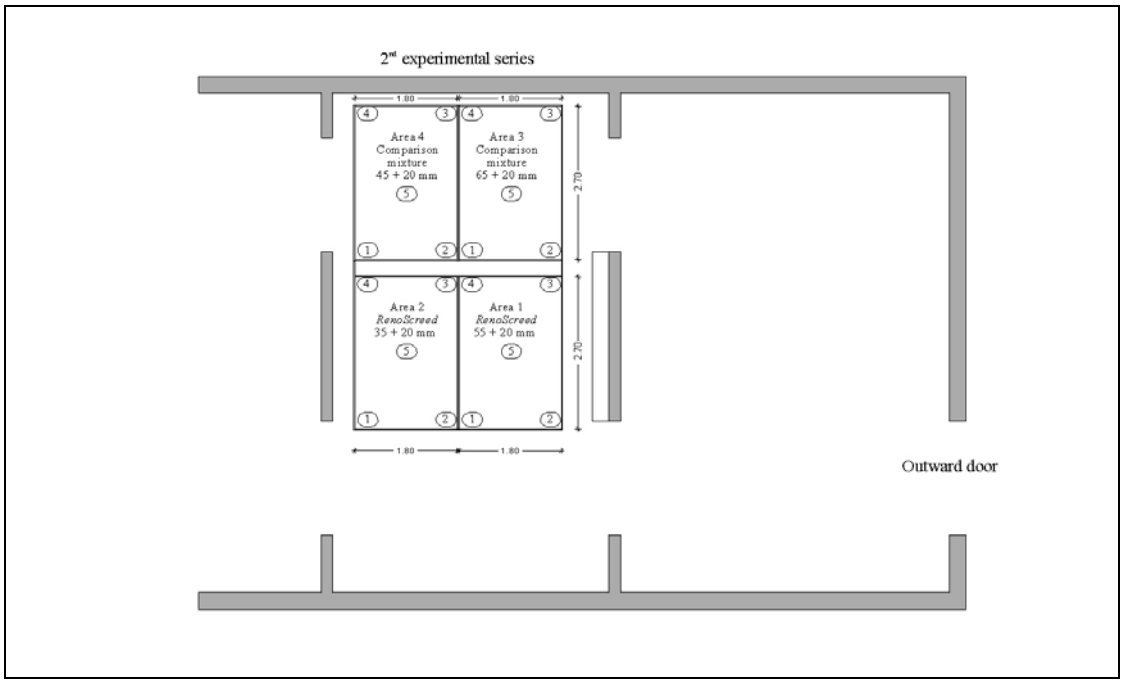


Illustration 2: Overview of the installed sample areas, 2nd ES.

The formulation of the compositions was specified by the "op" and was not communicated to the laboratory.

3. Test results

3.1 Curling behaviour

To measure the curling behaviour on each of the sample areas, an electronic displacement transducer was installed in each of the four corners and in the centre of the slab. The values measured by these five electronic displacement transducers were recorded throughout the test period. The two following illustrations show the edge curling behaviour of the two mixtures from the first experimental series:

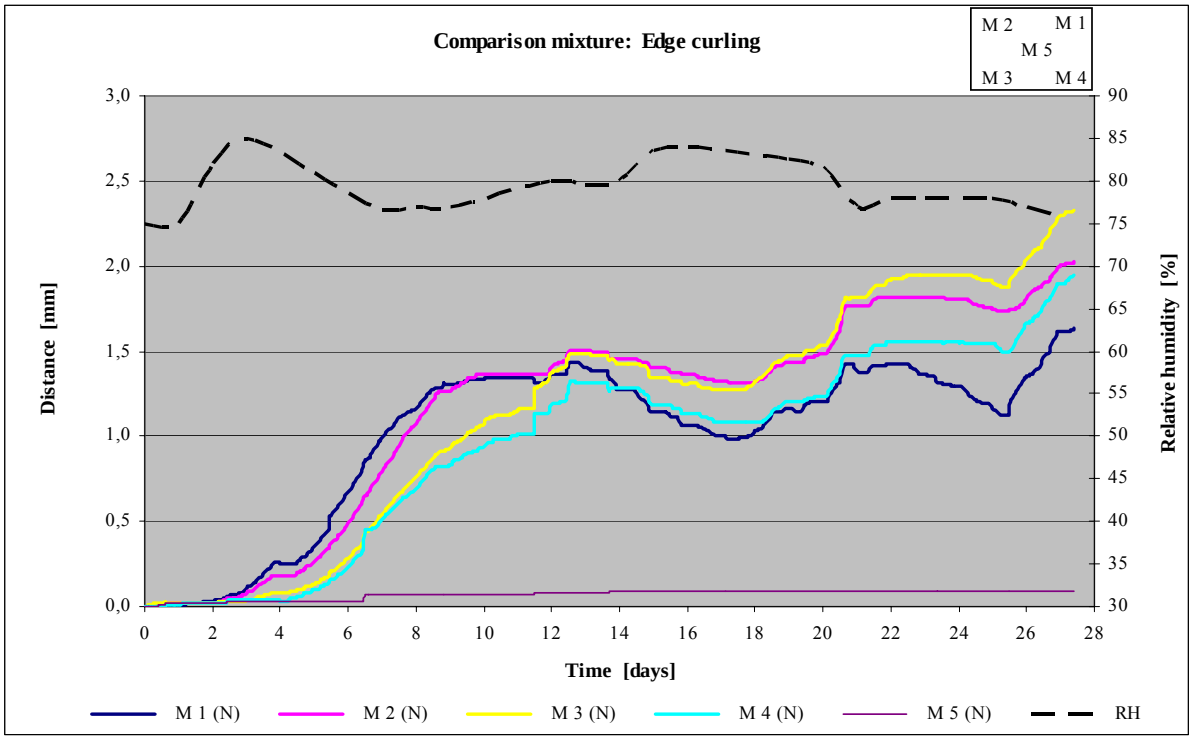


Illustration 3: Edge curling; 1st ES (comparison mixture); RH = Relative Humidity; (N) = comparison mixture.

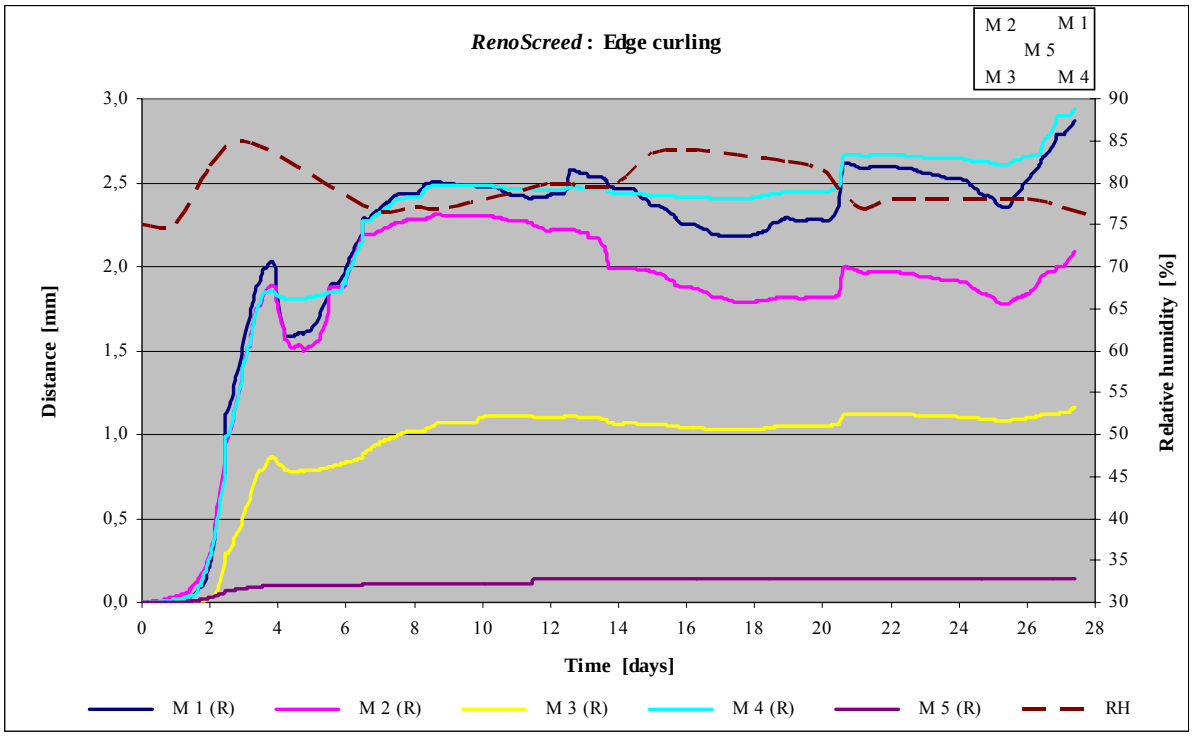


Illustration 4: Edge curling; 1st ES (*RenoScreed*); RH = Relative Humidity; (R) = *RenoScreed*.

On 1 August 2007 the surface of both screeds was watered by means of a hose and the water was evenly spread with a brush. The resulting resilience values are shown in the illustrations below:

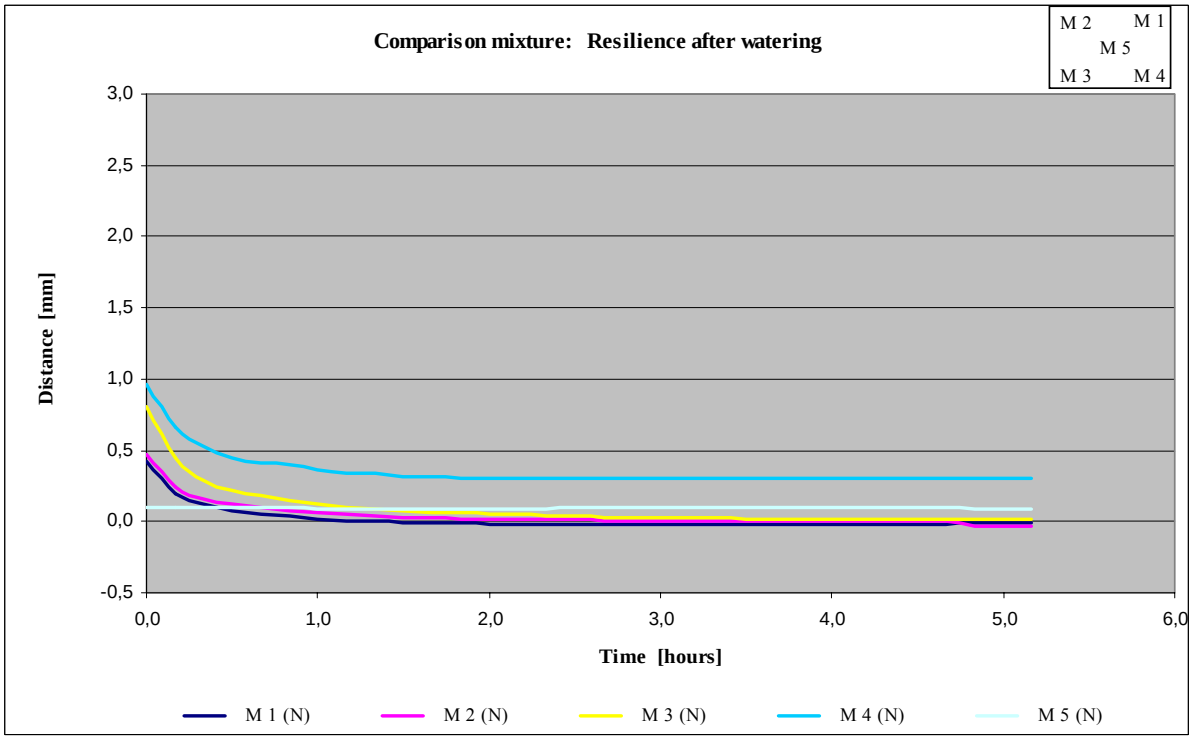


Illustration 5: Deformation of the comparison mixture after watering (1st ES); (N) = comparison mixture.

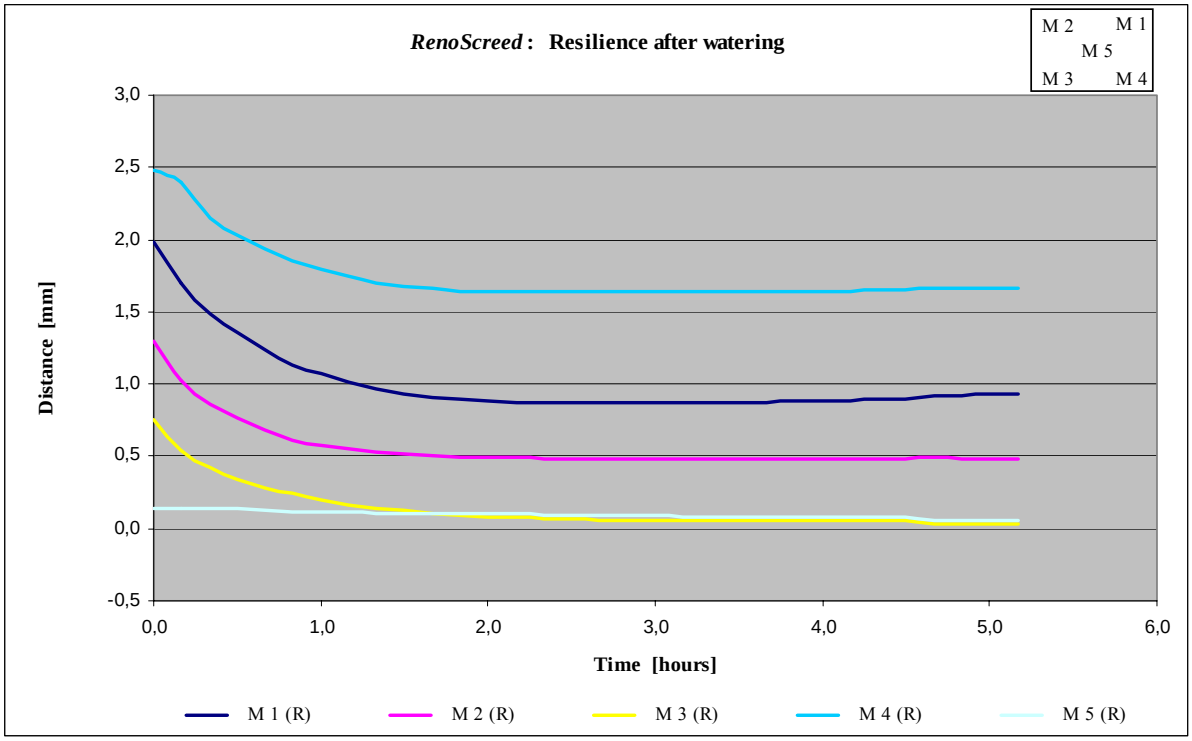


Illustration 6: Deformation of *RenoScreed* after watering (1st ES); (R) = *RenoScreed*.

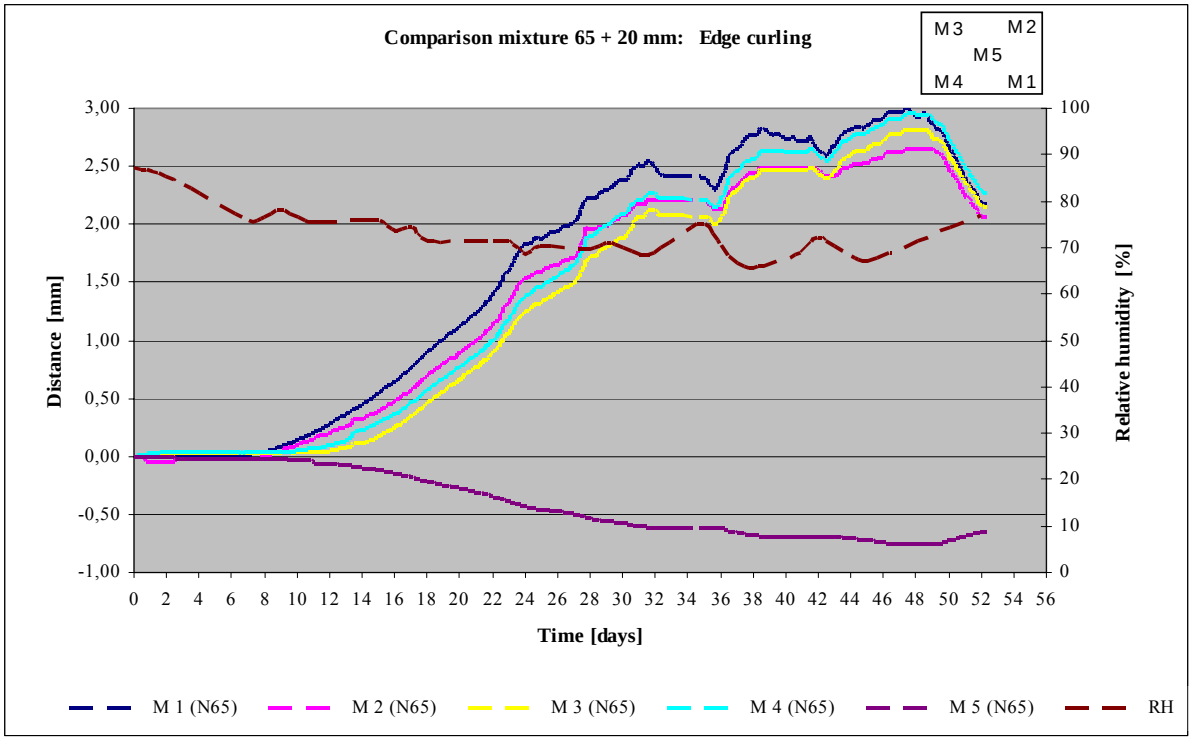


Illustration 7: Edge curling; 2nd ES (comparison mixture); RH = Relative Humidity; (N65) = comparison mixture, 65 mm.

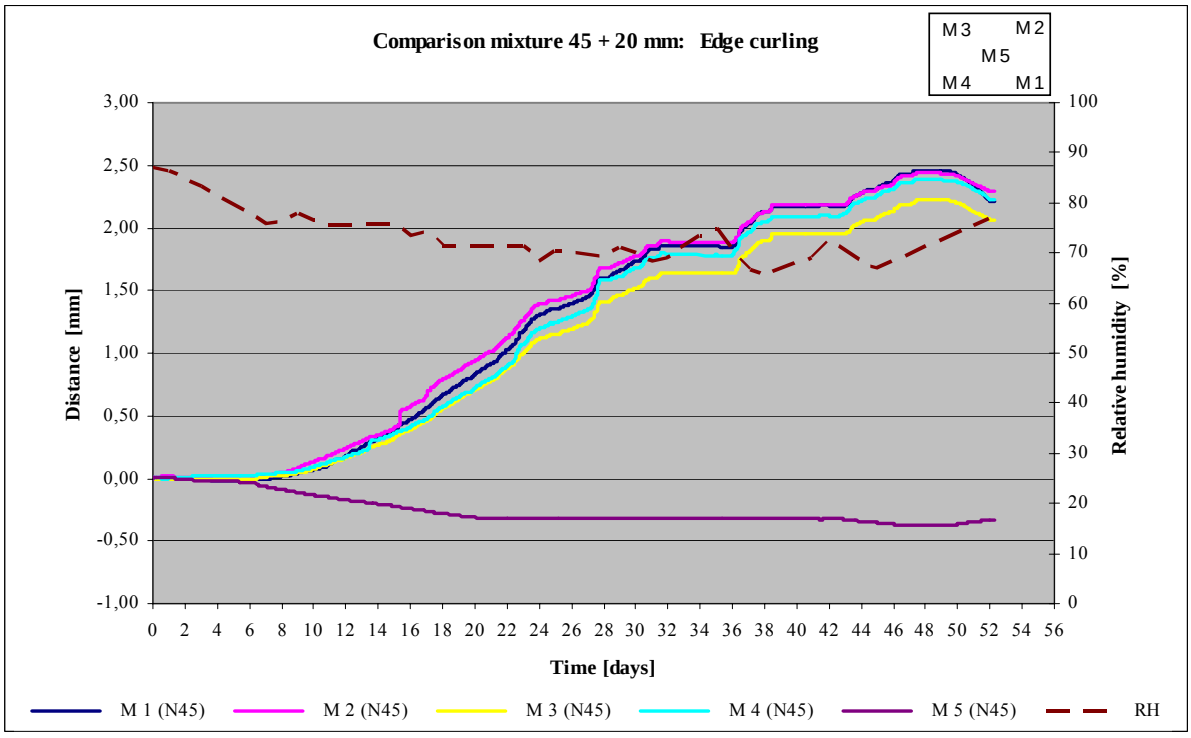


Illustration 8: Edge curling; 2nd ES (comparison mixture); RH = Relative Humidity; (N45) = comparison mixture, 45 mm.

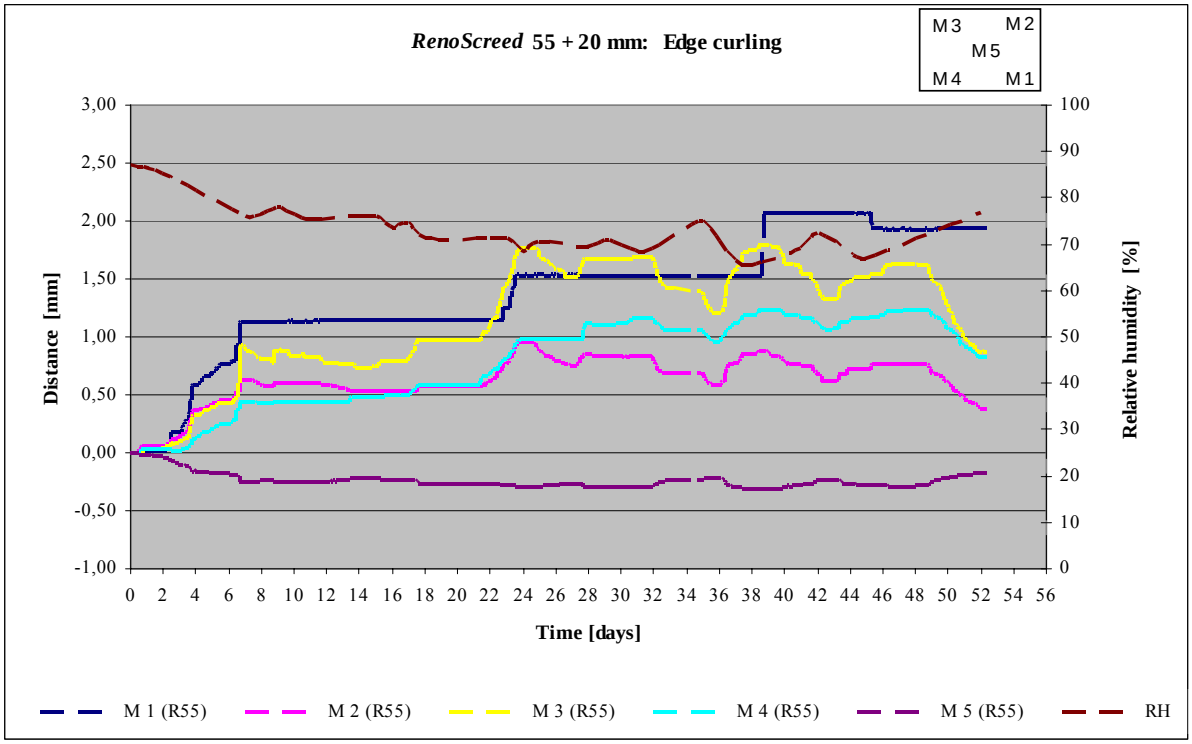


Illustration 9: Edge curling; 2nd ES (*RenoScreed*); RH = Relative Humidity; (R55) = *RenoScreed*, 55 mm.

Two of the five electronic displacement transducers of that experimental slab broke down during the measurement, so they could not be used to determine the edge curling.

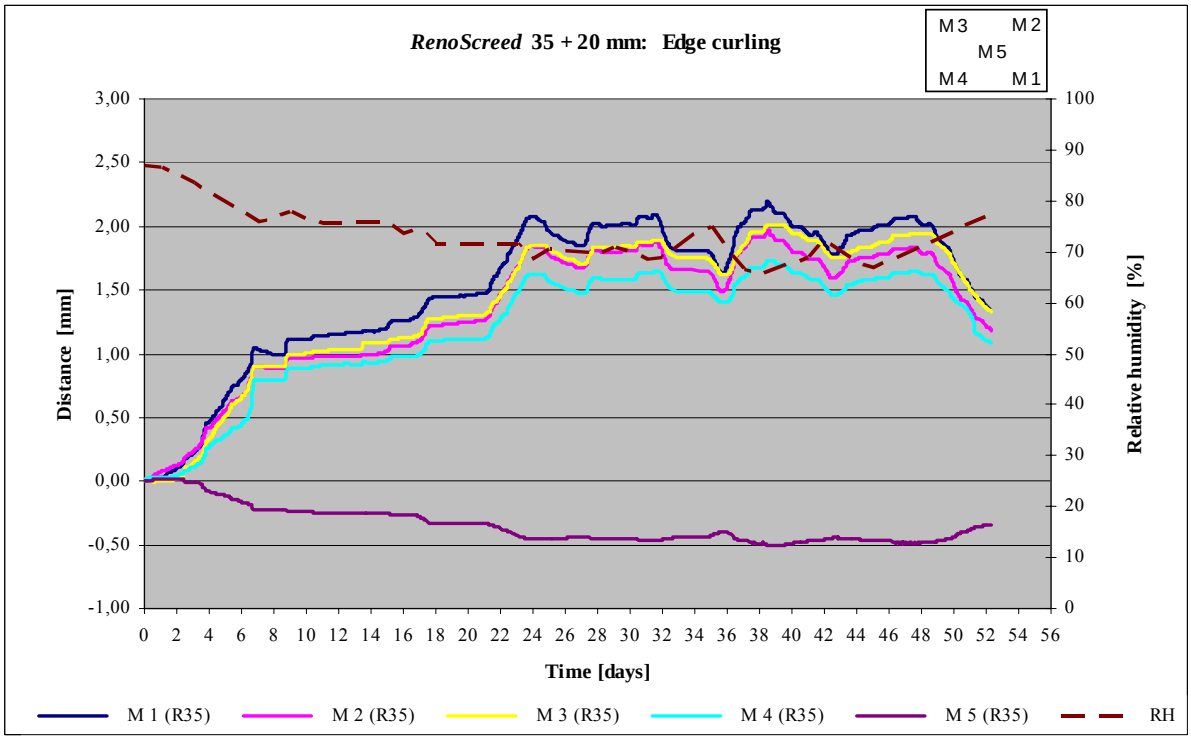


Illustration 10: Edge curling; 2nd ES (*RenoScreed*); RH = Relative Humidity; (R35) = *RenoScreed*, 35 mm.

The following graphs illustrate the resilience of the screeds which were watered on 5 October 2007.

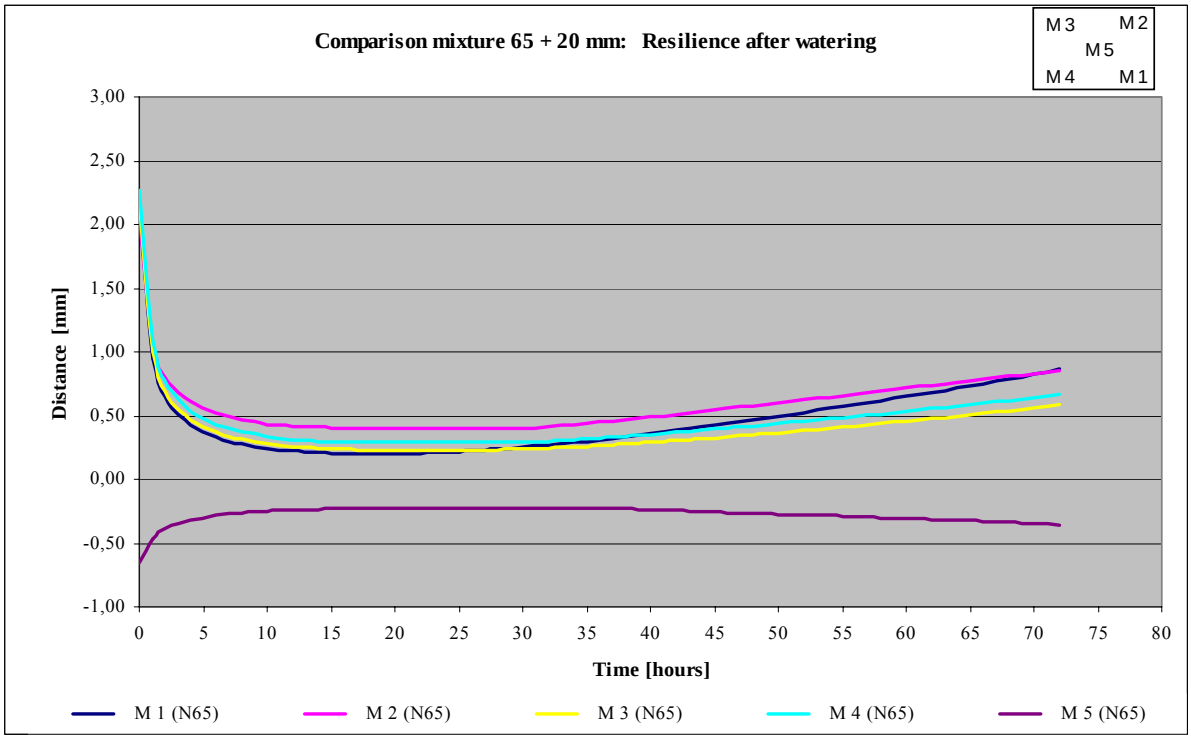


Illustration 11: Resilience; 2nd ES (comparison mixture); (N65) = comparison mixture, 65 mm.

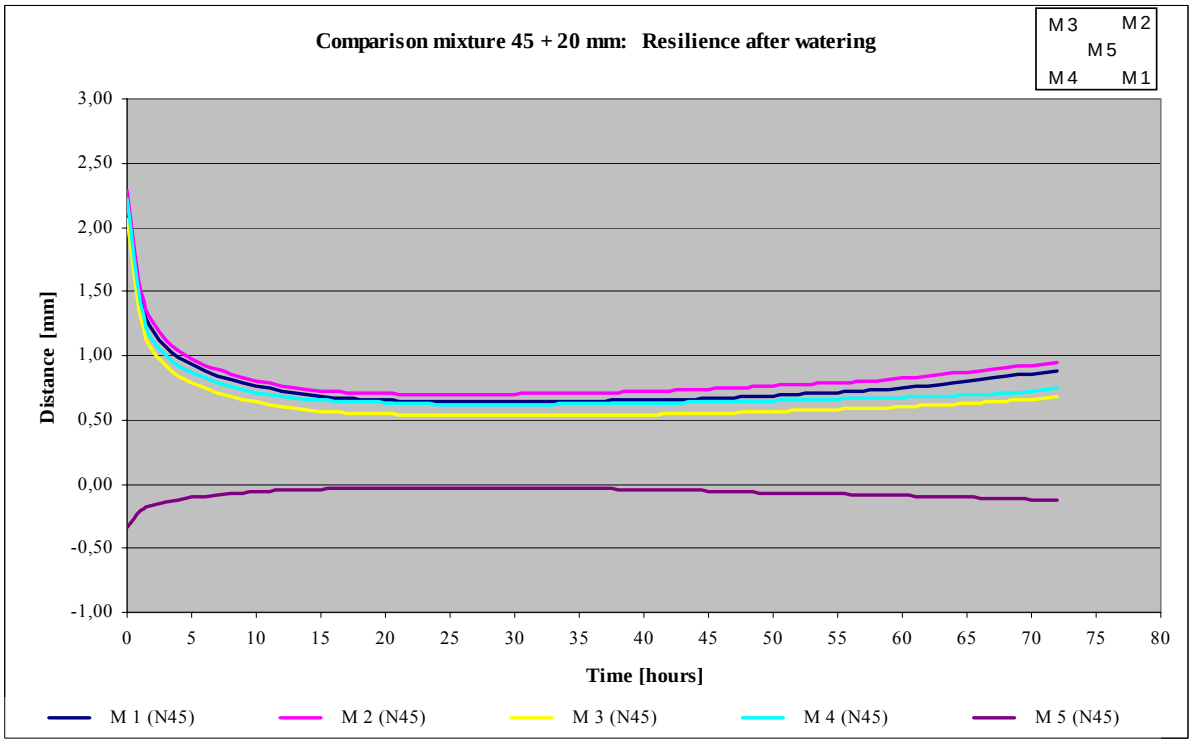


Illustration 12: Resilience; 2nd ES (comparison mixture); (N45) = comparison mixture, 45 mm.

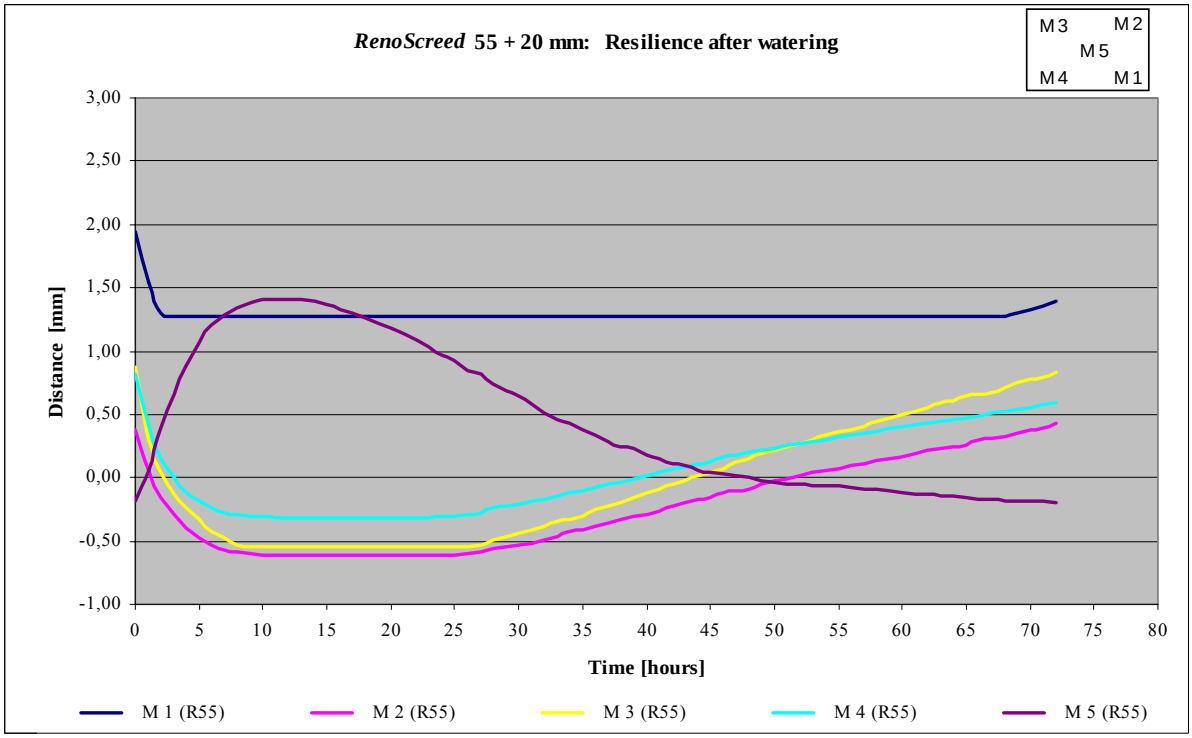


Illustration 13: Resilience; 2nd ES (*RenoScreed*); (R55) = *RenoScreed*, 55 mm.

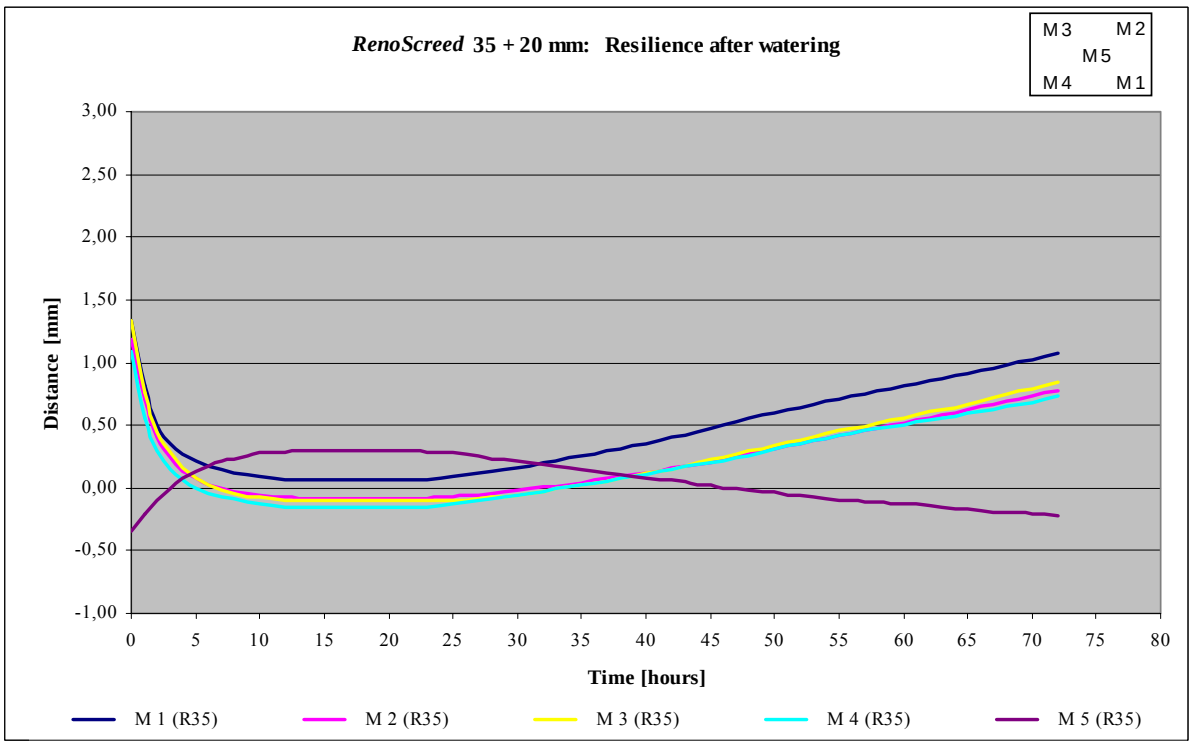


Illustration 14: Resilience; 2nd ES (*RenoScreed*); (R35) = *RenoScreed*, 35 mm.

In order to establish the behaviour of the comparison mixture and *RenoScreed* under stone and ceramic floorings on 29 November 2007 standard tiles were placed on all four sample areas.

Before laying the tiles the sample areas were cut into equal dimensions of 1.80 m x 1.30 m. As material for the tiles porcelain stoneware with an edge length of 34 x 34 cm and a thickness of 6 mm was used. It was glued to the screed with the help of 'PCI Nanolight' adhesive. The tiles were jointed right after the bonding to the screed with 'PCI Nanofug'.

The sample areas produced with the comparison mixture and with the *RenoScreed* mixture were examined on 15 February 2008. No damage could be established on both screed samples and on the tiles (e. g. in the form of cracks).

3.2 Drying process (moisture contents [% w/w])

- CM-moisture test

- Drying kiln test

- Electronic measurement

(1, 3, 7, 12, 13, 14 and 28 days after the screeds were laid)

[measuring devices: "Denzel" = G812 – "Gann" = Hydromette M4050 + B50]

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	"Gann"-method	"Denzel"-method
		Slab	Prism					
After laying	9.8	-	-	-	-	-	-	-
1 d	8.4	7.6	7.6	-	6.4	6.5	-	-
3 d	6.8	6.5	6.8	-	-	4.4	-	6.5
7 d	-	5.1	6.5	-	3.7	4.2	> 5.9	-
12 d	-	4.6	-	1.1	1.6	-	> 5.9	4.8
13 d	-	-	-	1.6	2.2	-	-	-
14 d	-	4.7	3.2	1.9	2.4	-	> 5.9	5.2
28 d	-	3.9	1.8	1.9	2.4	-	5.8	4.7

Table 2: Moisture contents [% w/w]; 1st ES (comparison mixture).

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	"Gann"-method	"Denzel"-method
		Slab	Prism					
After laying	8.1	-	-	-	-	-	-	-
1 d	6.4	5.6	5.9	-	4.8	4.9	-	-
3 d	5.7	4.7	5.3	-	1.9	2.5	-	5.5
7 d	-	4.3	5.2	-	2.9	3.2	5.7	-
12 d	-	4.2	-	0.5	0.8	-	5.9	4.9
13 d	-	-	-	0.7	1.2	-	-	-
14 d	-	3.6	3.3	1.7	2.2	-	5.8	4.4
28 d	-	3.0	2.5	1.7	2.3	-	5.8	4.7

Table 3: Moisture contents [% w/w]; 1st ES (*RenoScreed*).

The moisture content values of the second experimental series are presented in the subsequent tables:

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	"Gann"-method
		Slab	prism				
After laying	11.0						
1 d	9.6	9.0	8.2	8.9	9.5	-	10.0
3 d	7.7	7.2	7.6	5.9	6.7	-	6.2
7 d	-	6.4	7.6	4.4	5.2	> 5.9	5.5
14 d	-	5.6	7.2	3.3	4.1	-	5.4
28 d	-	5.5	3.6	3.6	4.4	5.8	4.6
56 d	-	4.8	-	1.9	2.4	3.5	-

Table 4: Moisture contents [% w/w] of the comparison mixture (65 + 20 mm), 2nd ES.

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	"Gann"-method
		Slab	prism				
After laying	11.0						
1 d	10.0	7.5	8.2	9.5	10.0	-	10.0
3 d	9.1	7.9	7.6	4.9	5.9	-	6.3
7 d	-	7.5	7.6	4.4	5.8	> 5.9	5.8
14 d	-	6.4	7.2	2.8	3.4	-	4.8
28 d	-	5.6	3.6	3.6	4.2	5.8	4.5
56 d	-	4.7	-	2.7	2.9	4.0	3.4

Table 5: Moisture contents [% w/w] of the comparison mixture (45 + 20 mm), 2nd ES.

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	"Gann"-method
		Slab	prism				
After laying	8.2	-	-	-	-	-	-
1 d	6.8	6.0	6.0	4.6	5.0	-	5.5
3 d	5.5	4.8	5.1	3.4	4.0	-	4.8
7 d	-	4.7	5.2	1.4	1.9	2.8	4.3
14 d	-	4.2	5.1	1.0	1.5	2.3	4.5
28 d	-	4.1	3.8	1.9	2.3	5.5	4.2
56 d	-	3.9	-	0.9	1.2	3.4	3.9

Table 6: Moisture contents [% w/w] of *RenoScreed* (55 + 20 mm), 2nd ES.

Days	Kiln-dried (≈ 250°C)	Kiln-dried (105°C)		CM 10 min	CM 30 min	CM 60 min	„Gann"-method
		slab	prism				
After laying	8.2	-	-	-	-	-	-
1 d	6.3	5.5	6.0	3.8	4.9	-	5.4
3 d	5.7	4.5	5.1	4.5	6.0	-	5.0
7 d	-	4.5	5.2	1.2	1.7	2.4	4.5
14 d	-	4.0	5.1	1.2	1.7	5.1	4.8
28 d	-	3.9	3.8	1.9	2.3	5.1	4.0
56 d	-	3.7	-	1.0	1.6	3.7	4.3

Table 7: Moisture contents [% w/w] of *RenoScreed* (35 + 20 mm), 2nd ES.

3.3 Shrinkage behaviour (prisms [4 x 4 x 16 cm] storage under conditions equal to the sample areas)

While manufacturing the sample areas, 6 x 3 prisms were extracted from each mixture. Three prisms from each mixture were stored next to the sample areas, which were measured regularly to record the shrinkage deformation.

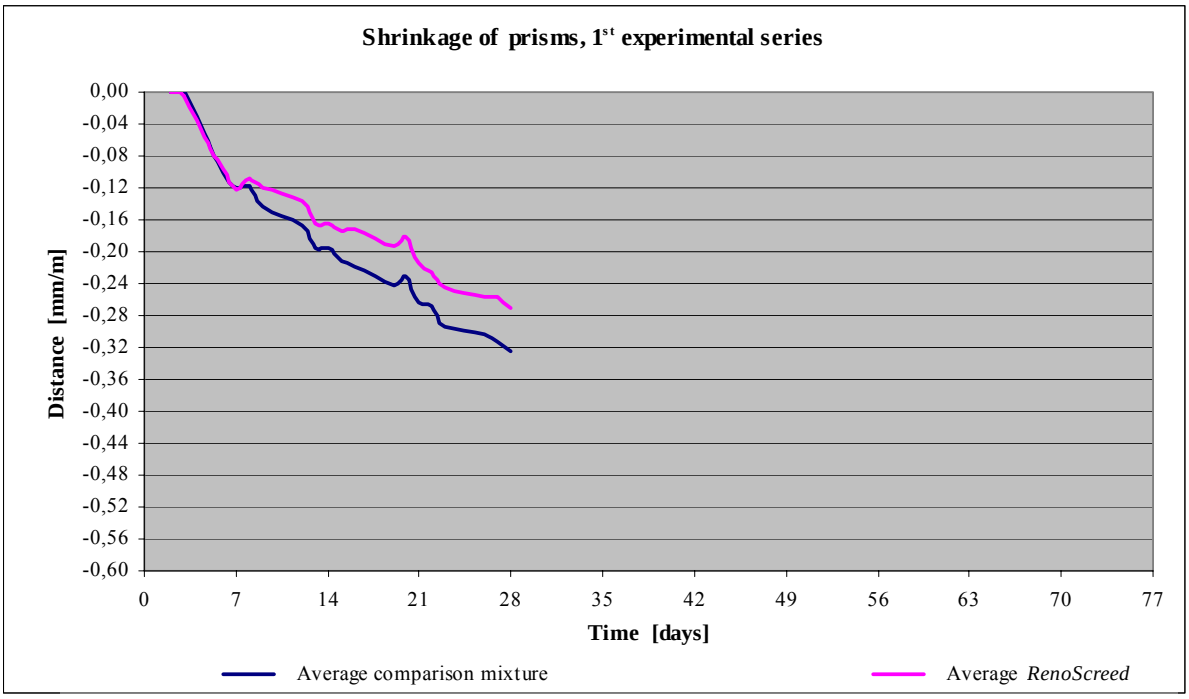


Illustration 15: Shrinkage of prisms; 1st ES.

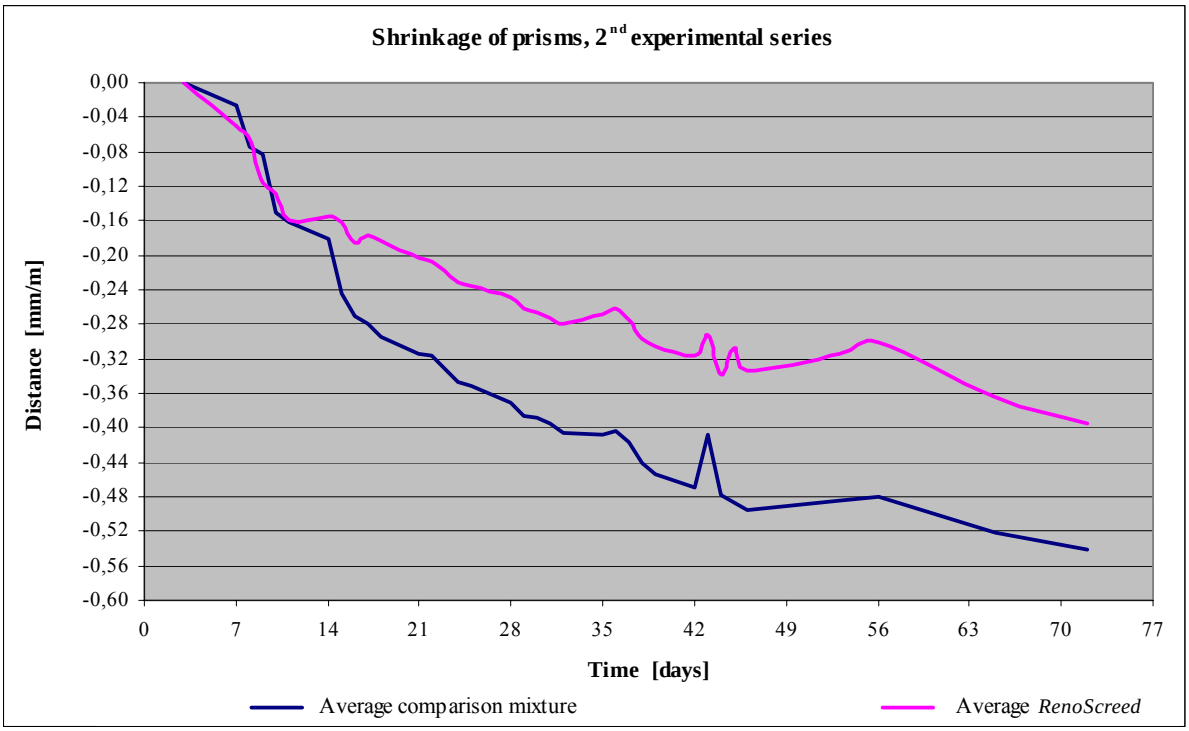


Illustration 16: Shrinkage of prisms; 2nd ES.

3.4 Load tests on prisms - prisms (4 x 4 x 16 cm) after 1, 3, 7, 14 and 28 days

The prisms manufactured while the sample areas were being laid were used to measure the shrinkage as well as the compressive strength and the flexural tensile strength. The structural strength of the three prisms was tested on the aforementioned days.

Days	Compressive strength [N/mm²]		Flexural tensile strength [N/mm²]	
	Comparison mixture	*RenoScreed*	Comparison mixture	*RenoScreed*
1	10.6	20.9	2.2	4.2
3	21.0	44.3	4.0	6.8
7	29.9	52.3	5.2	7.1
14	35.5	64.4	5.5	8.2
28	39.2	71.5	6.5	9.1

Table 8: Compressive strength and flexural tensile strength values; 1st ES.

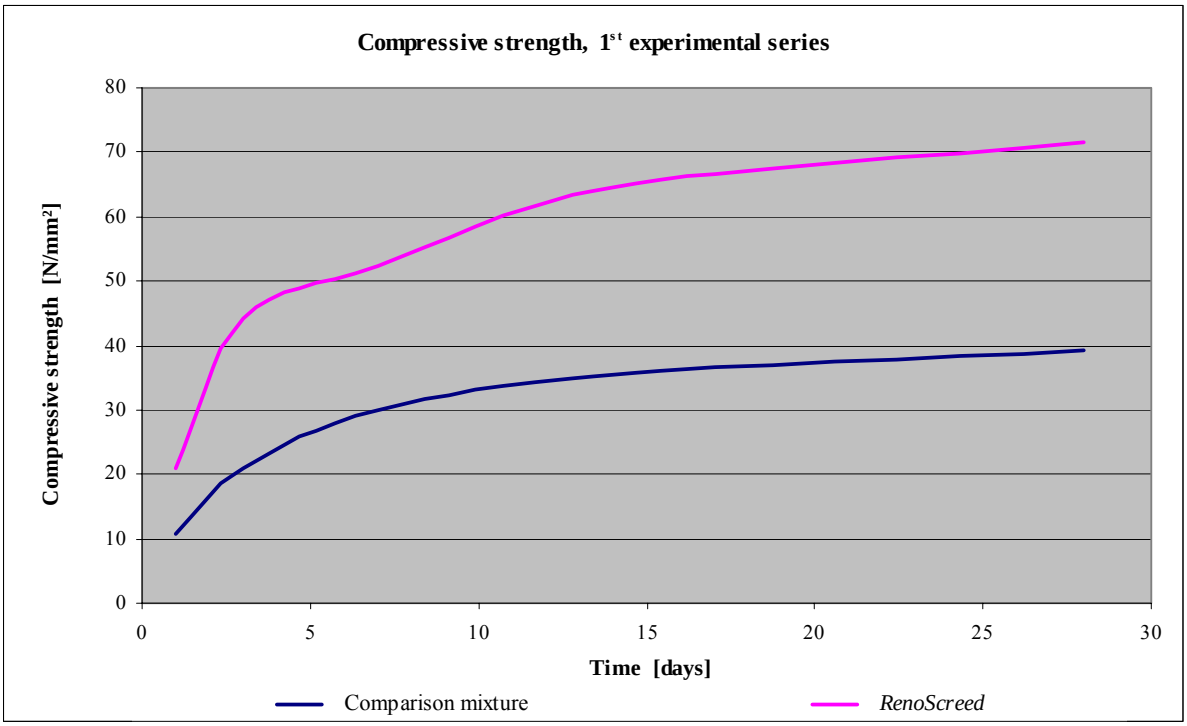


Illustration 17: Compressive strength of both mixtures; 1st ES.

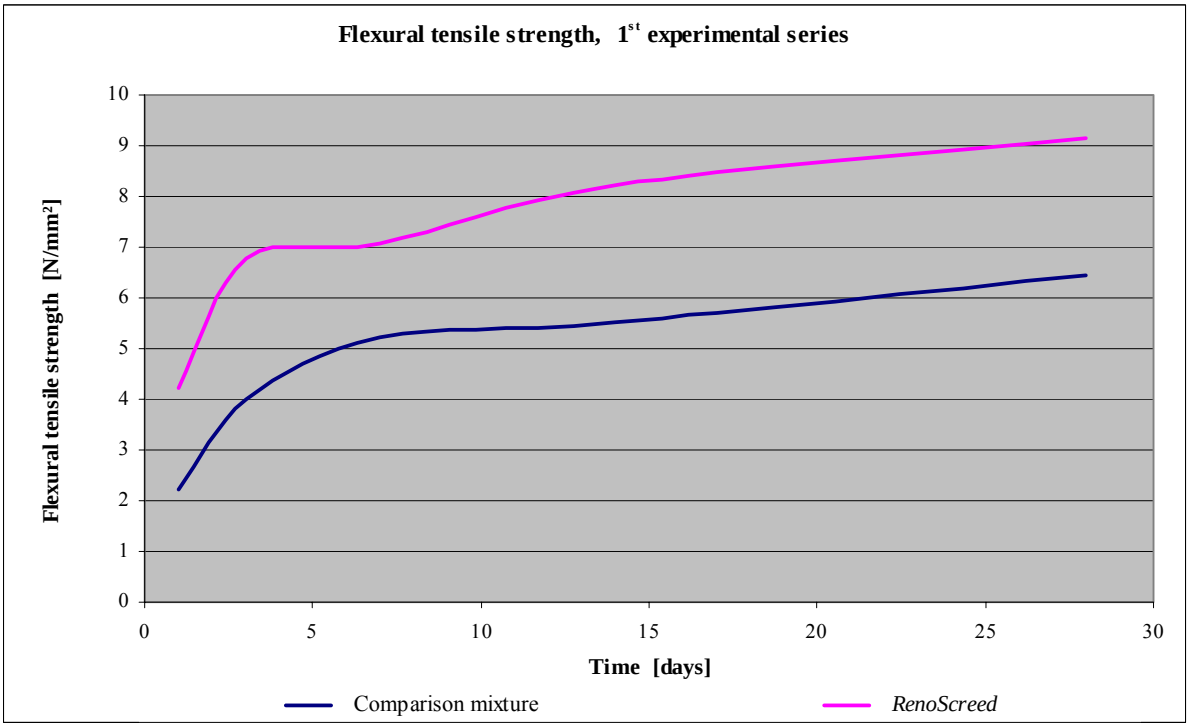


Illustration 18: Flexural tensile strength of both mixtures; 1st ES.

Days	Compressive strength [N/mm²]		Flexural tensile strength [N/mm²]	
	Comparison mixture	*RenoScreed*	Comparison mixture	*RenoScreed*
1	5.9	17.8	1.2	3.4
3	14.1	36.3	2.9	6.1
7	18.1	43.1	2.3	6.2
14	24.0	49.4	3.9	6.6
28	31.0	63.0	5.1	8.5

Table 9: Compressive strength and flexural tensile strength values; 2nd ES.

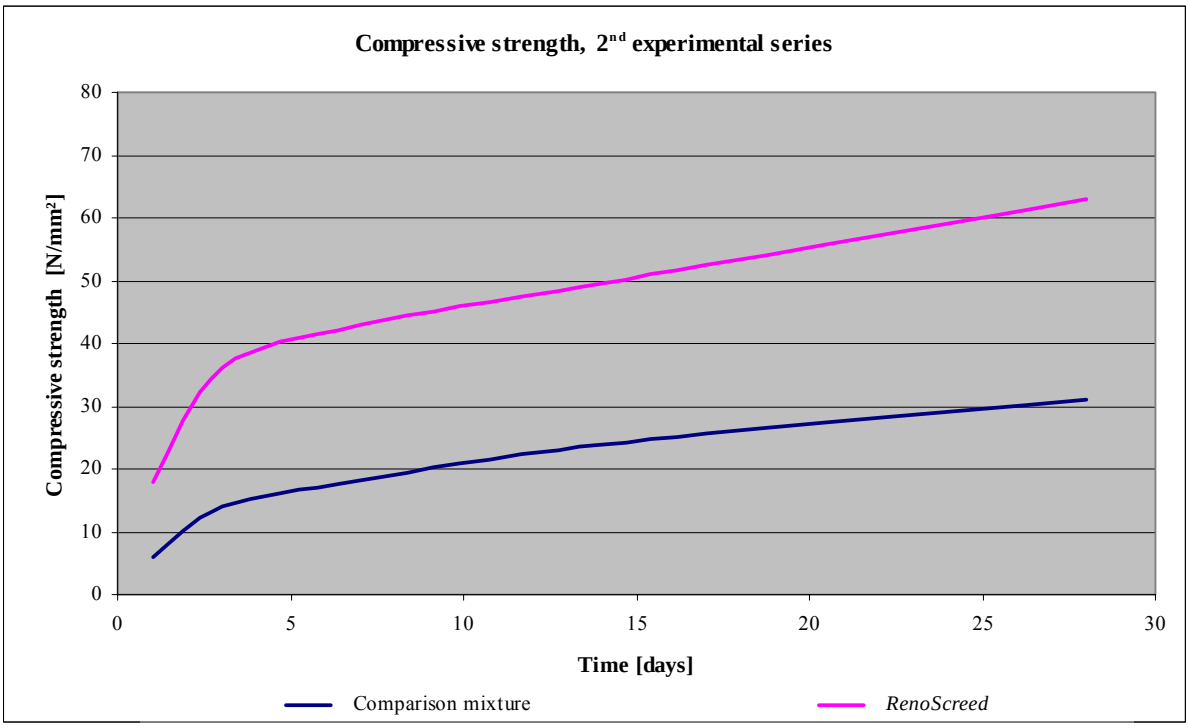


Illustration 19: Compressive strength values; 2nd ES (both mixtures).

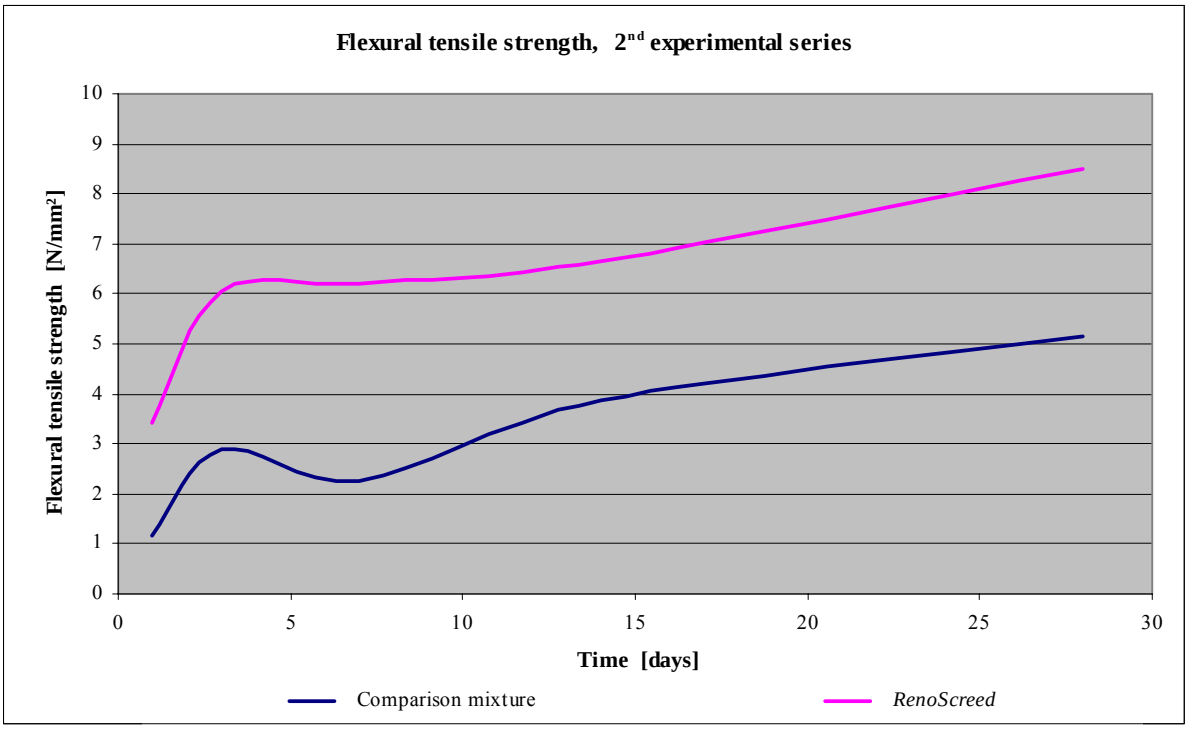


Illustration 20: Flexural tensile strength values; 2nd ES (both mixtures).

3.5 Load tests on plate samples and results of the confirmation test

For the confirmation test of the first experimental series, plates of each sample area were cut out dry. To measure the compressive strength, strips were cut out of the sample areas with a length : width relation of 1 : 1.

To measure the flexural tensile strength, the extracted plates were cut into test pieces with a width of 6 cm and then cut to the corresponding length, their thickness being about 6 times the width. Afterwards these specimens were tested by using the 3-point bending test for determining the flexural tensile strength, the thickness being 5 times the span.

The following tables and graphs show the compressive strength and the flexural tensile strength values measured and tested with the comparison mixture.

Sample no.	Width 1	Width 2	Height	Breaking load	Compressive strength	
						Average
	[mm]	[mm]	[mm]	[N]	[N/mm²]	[N/mm²]
Comparison mixture						
Null LV 1	33.4	32.7	33.3	22.205	20.34	19.53
Null LV 2	33.5	34.5	33.8	21.312	18.45	
Null LV 3	33.0	33.5	33.3	19.586	17.73	
Null LV 4	33.4	32.5	32.9	22.203	20.42	
Null LV 5	34.9	33.8	32.5	29.296	24.87	
Null LV 6	34.7	33.9	32.6	14.123	12.02	
Null LV 7	33.8	34.7	32.4	26.779	22.88	
Null LH 1	30.4	31.2	30.2	16.507	17.36	15.21
Null LH 2	30.7	31.6	30.7	16.261	16.80	
Null LH 3	30.6	31.5	32.1	13.867	14.35	
Null LH 4	30.4	31.6	31.1	15.818	16.46	
Null LH 5	30.8	31.6	31.4	10.743	11.05	

Table 10: Compressive strength values; 1st ES (comparison mixture).
("Null" = comparison mixture)

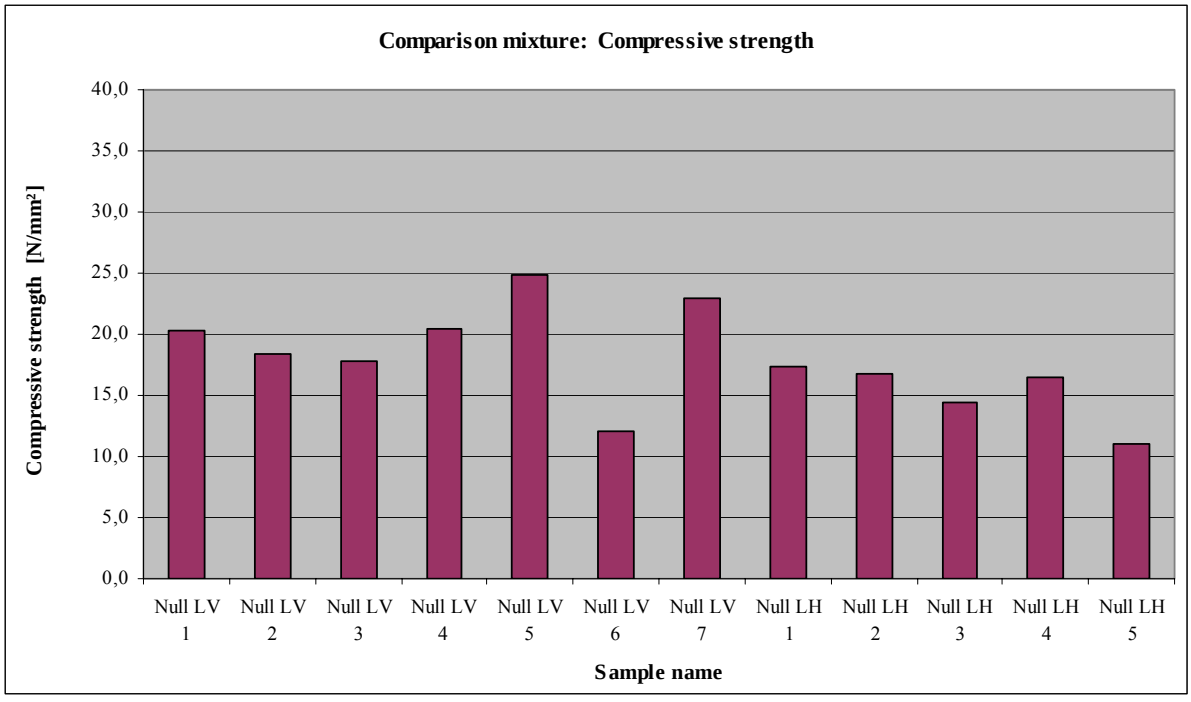


Illustration 21: Compressive strength values; 1st ES (comparison mixture).

Test date	Sample no.	Span	Test speed		Breaking load	Site of fracture		Flexural tensile strength	
						Width	Thickness		Average
		[mm]	[N/mm²*s]	[N/s]	[N]	[mm]	[mm]	[N/mm²]	[N/mm²]
Comparison mixture									
09.08.07	N - LV 1	146	0.1	22.1	1.483	60.8	27.8	6.92	5.74
09.08.07	N - LV 2	146	0.1	26.2	854	61.0	31.6	3.08	
09.08.07	N - LV 3	146	0.1	25.6	969	60.2	30.3	3.83	
09.08.07	N - LV 4	146	0.1	25.0	1.201	60.2	30.0	4.85	
09.08.07	N - LV 5	146	0.1	23.8	1.933	59.7	29.4	8.24	
09.08.07	N - LV 6	146	0.1	24.0	1.754	60.8	28.4	7.82	
09.08.07	N - LV 7	146	0.1	21.5	833	60.2	27.5	3.99	
09.08.07	N - LV 8	146	0.1	20.4	1.432	60.3	27.0	7.17	
09.08.07	N - LH 1	155	0.1	24.8	945	60.6	30.8	3.83	5.15
09.08.07	N - LH 2	155	0.1	23.9	849	60.8	29.3	3.78	
09.08.07	N - LH 3	155	0.1	21.7	1.497	60.1	31.3	5.90	
09.08.07	N - LH 4	155	0.1	25.9	1.267	59.8	32.0	4.80	
09.08.07	N - LH 5	155	0.1	24.3	701	59.8	30.4	2.94	
09.08.07	N - LH 6	155	0.1	27.5	1.317	59.4	32.8	4.78	
09.08.07	N - LH 7	155	0.1	25.9	1.762	60.7	29.0	8.05	
09.08.07	N - LH 8	155	0.1	24.2	1.707	60.2	30.4	7.14	

Table 11: Flexural tensile strength values; 1st ES (comparison mixture).

$$\text{Flexural tensile strength } \beta_f = \frac{1.5 \cdot F \cdot s}{w \cdot t^2}$$

F = Breaking load – s = span – w = width – t = thickness

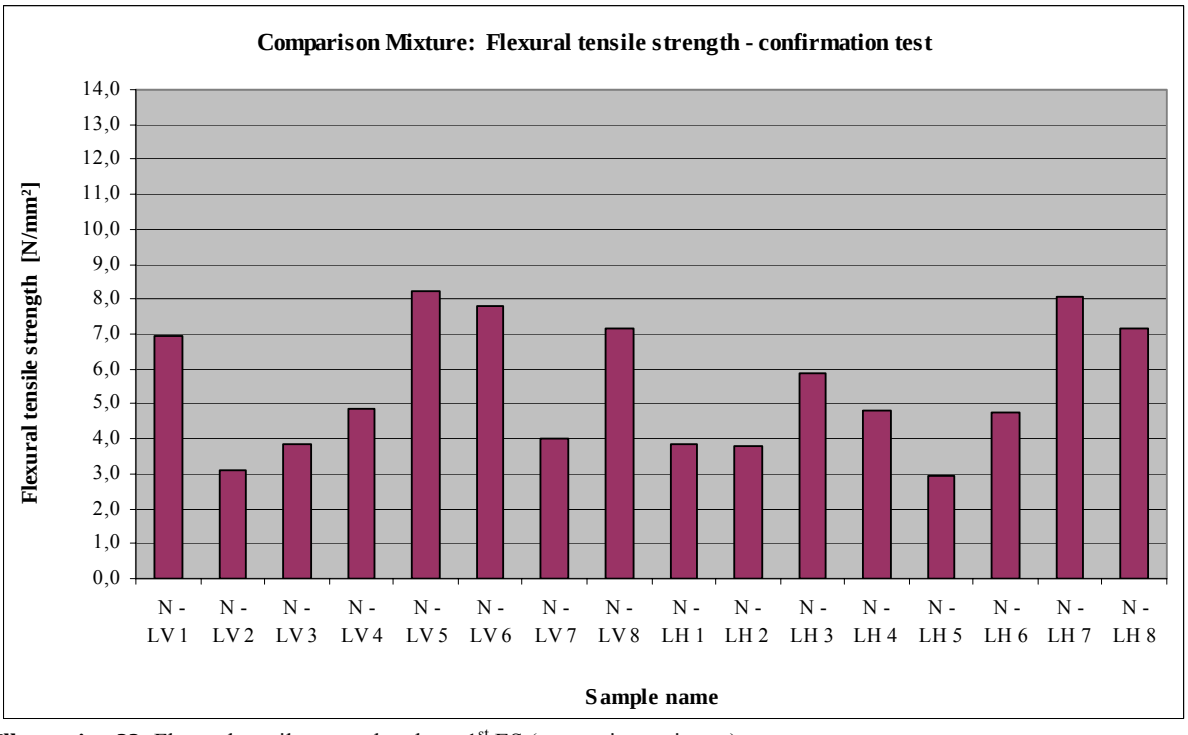


Illustration 22: Flexural tensile strength values; 1st ES (comparison mixture).

The compressive strength tests with *RenoScreed* were conducted in accordance with the tests of the comparison mixture. The next table illustrates the compressive strength values.

Sample no.	Width 1	Width 2	Height	Breaking load	Compressive strength	
						Average
	[mm]	[mm]	[mm]	[N]	[N/mm²]	[N/mm²]
RenoScreed						
Reno RV 1	29.7	29.8	28.2	14.622	16.53	26.77
Reno RV 2	29.6	30.0	28.0	31.821	35.88	
Reno RV 3	29.3	29.2	29.5	16.600	19.41	
Reno RV 4	29.9	29.4	27.8	32.445	36.95	
Reno RV 5	29.6	29.6	28.4	30.264	34.55	
Reno RV 6	29.3	29.9	30.0	15.108	17.28	
Reno RH 1	23.3	23.4	23.5	14.755	27.10	30.73
Reno RH 2	23.5	23.3	23.3	14.918	27.27	
Reno RH 3	23.5	23.3	23.7	19.667	35.80	
Reno RH 4	23.5	23.4	24.5	18.277	33.32	
Reno RH 5	23.6	23.0	24.4	16.927	31.24	
Reno RH 6	23.1	23.3	23.2	15.555	29.00	
Reno RH 7	23.4	23.3	23.9	16.825	30.85	
Reno RH 8	23.6	23.3	24.0	17.185	31.28	

Table 12: Compressive strength values; 1st ES (*RenoScreed*).

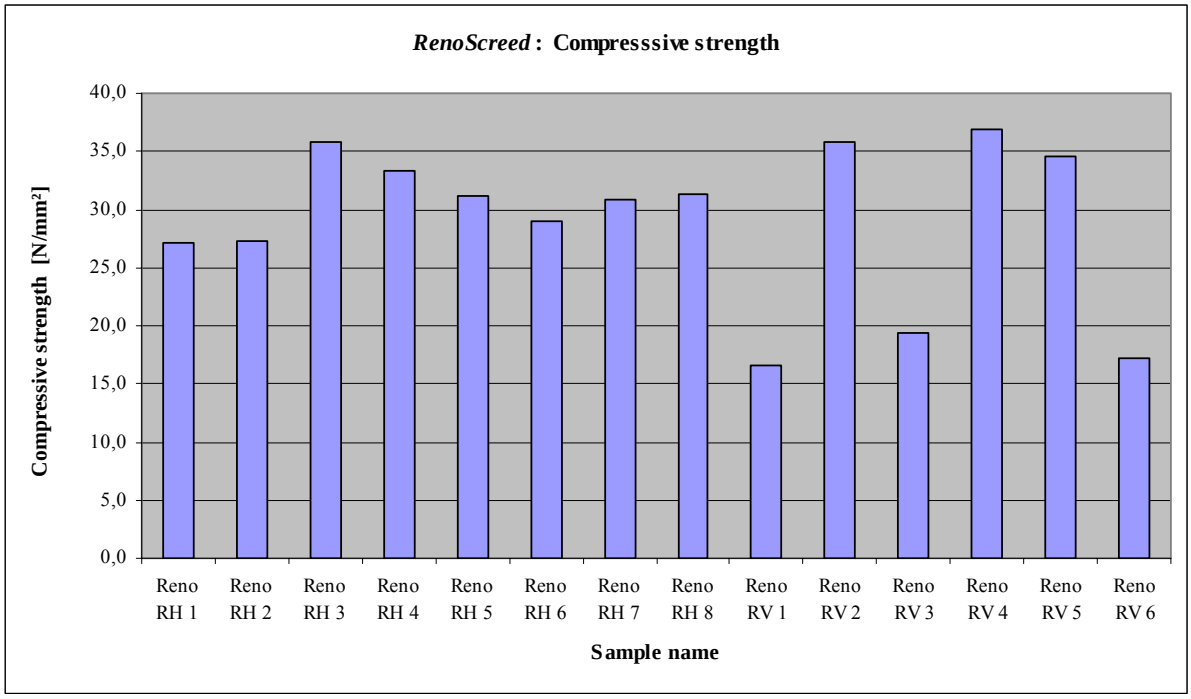


Illustration 23: Compressive strength values; 1st ES (*RenoScreed*).

The following table illustrates the results of the *RenoScreed* composition from the confirmation test:

Test date	Sample no.	Span	Test speed		Breaking load	Site of fracture		Flexural tensile strength	
						Width	Thickness		Average
		[mm]	[N/mm²*s]	[N/s]	[N]	[mm]	[mm]	[N/mm²]	[N/mm²]
RenoScreed									
09.08.07	RS - RV 1	136	0.1	21.9	1.816	60.6	26.6	8.64	
09.08.07	RS - RV 2	136	0.1	23.6	1.636	60.9	27.7	7.13	
09.08.07	RS - RV 3	136	0.1	21.0	1.703	60.6	25.9	8.53	
09.08.07	RS - RV 4	136	0.1	21.0	1.759	60.8	26.3	8.50	8.09
09.08.07	RS - RV 5	136	0.1	21.9	1.484	60.5	26.3	7.22	
09.08.07	RS - RV 6	136	0.1	22.2	1.944	60.4	27.3	8.81	
09.08.07	RS - RV 7	136	0.1	21.4	1.680	60.4	26.9	7.82	
09.08.07	RS - RH 1	132	0.1	21.7	1.886	60.4	26.1	9.04	
09.08.07	RS - RH 2	132	0.1	21.5	1.615	61.0	25.9	7.84	
09.08.07	RS - RH 3	132	0.1	20.1	1.469	60.6	25.6	7.33	
09.08.07	RS - RH 4	132	0.1	21.3	1.638	60.2	27.0	7.39	7.67
09.08.07	RS - RH 5	132	0.1	20.9	1.366	61.2	27.1	6.02	
09.08.07	RS - RH 6	132	0.1	22.0	1.670	59.9	26.5	7.87	
09.08.07	RS - RH 7	132	0.1	20.6	1.695	60.7	25.3	8.66	
09.08.07	RS - RH 8	132	0.1	21.5	1.554	60.8	26.5	7.24	

Table 13: Flexural tensile strength values; 1st ES (*RenoScreed*).

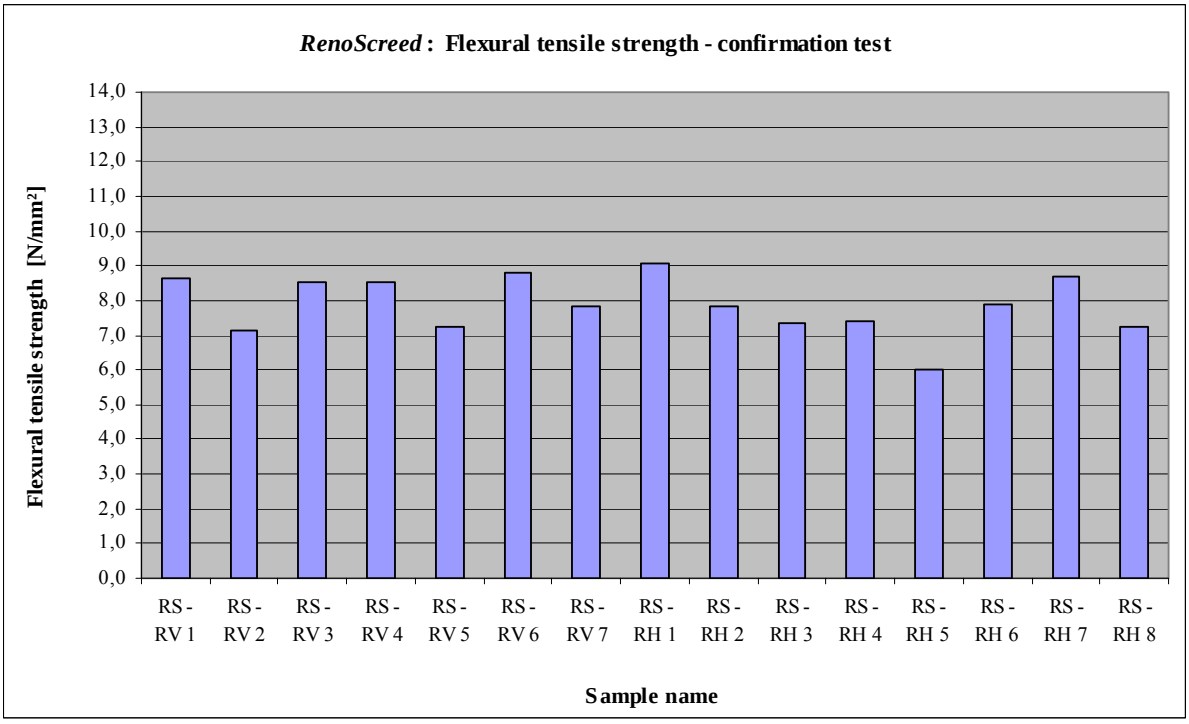


Illustration 24: Flexural tensile strength values; 1st ES (*RenoScreed*).

For the second experimental series the same test programme was conducted as in the first experimental series. Since the four slabs show different thicknesses, twice the number of slabs, strips and cubes were needed for the test.

The following table gives an overview of the compressive strength values of the comparison mixture from the second experimental series:

Test date	Sample no.	Width 1	Width 2	Height	Breaking load	Compressive strength	
							Average
		[mm]	[mm]	[mm]	[N]	[N/mm²]	[N/mm²]
Comparison mixture 65 + 20 mm							
22.10.07	N 65 1.1	63.3	63.4	62.4	60.258	15.0	17.0
22.10.07	N 65 1.2	63.2	62.8	64.1	69.667	17.6	
22.10.07	N 65 1.3	63.3	64.0	63.8	71.170	17.6	
22.10.07	N 65 1.4	62.8	63.4	63.7	71.689	18.0	
22.10.07	N 65 1.5	62.7	63.7	63.0	68.112	17.1	
22.10.07	N 65 2.1	66.3	66.1	66.5	77.412	17.7	16.2
22.10.07	N 65 2.2	65.8	66.6	66.5	79.646	18.2	
22.10.07	N 65 2.3	66.3	67.2	66.8	74.566	16.7	
22.10.07	N 65 2.4	66.5	66.4	64.5	70.183	15.9	
22.10.07	N 65 2.5	58.4	59.4	59.6	42.797	12.3	
Comparison mixture 45 + 20 mm							
22.10.07	N 45 1.1	46.9	46.4	47.2	27.204	12.5	14.5
22.10.07	N 45 1.2	46.4	46.5	47.5	33.674	15.6	
22.10.07	N 45 1.3	46.5	46.5	45.7	31.058	14.4	
22.10.07	N 45 1.4	46.2	46.0	44.9	32.064	15.1	
22.10.07	N 45 1.5	46.3	47.0	46.4	32.030	14.7	
22.10.07	N 45 2.1	47.6	47.4	46.4	34.706	15.4	13.4
22.10.07	N 45 2.2	47.5	47.4	47.3	23.128	10.3	
22.10.07	N 45 2.3	46.5	47.7	47.5	29.028	13.1	
22.10.07	N 45 2.4	45.3	45.7	43.7	32.432	15.7	
22.10.07	N 45 2.5	47.2	47.5	46.5	28.273	12.6	

Table 14: Compressive strength values; 2nd ES (comparison mixture).

The results from the table above are shown in the following illustrations:

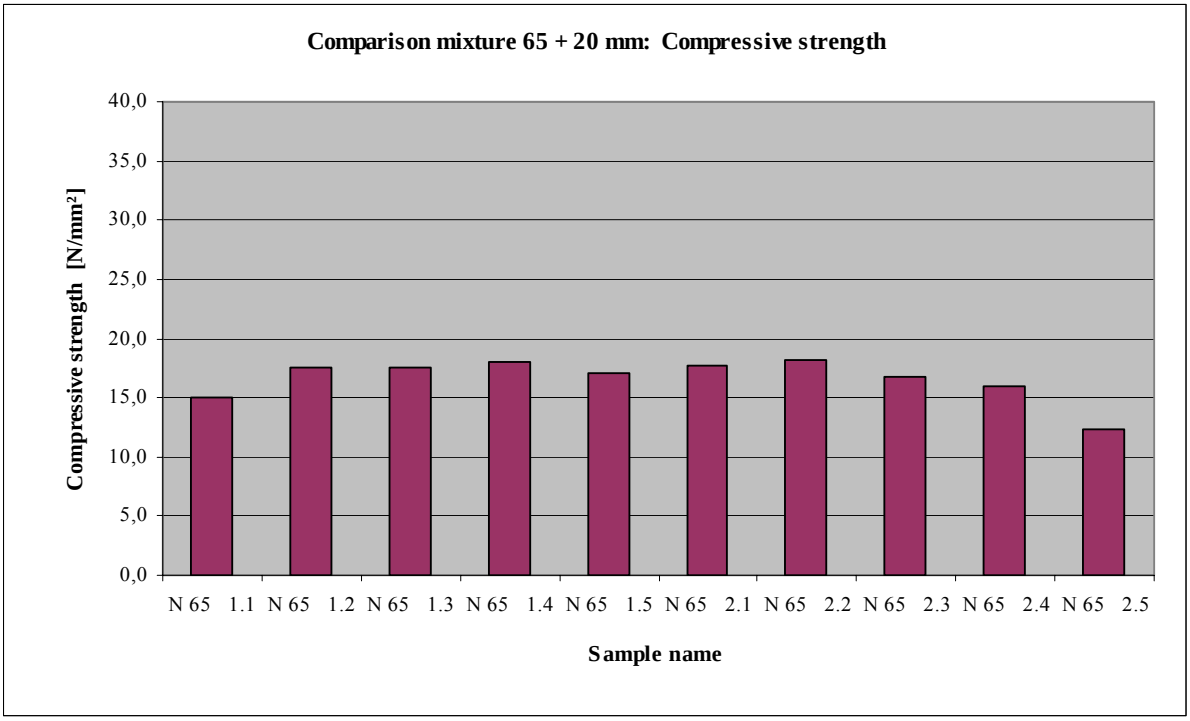


Illustration 25: Compressive strength values – comparison mixture (65 + 20 mm); 2nd ES.

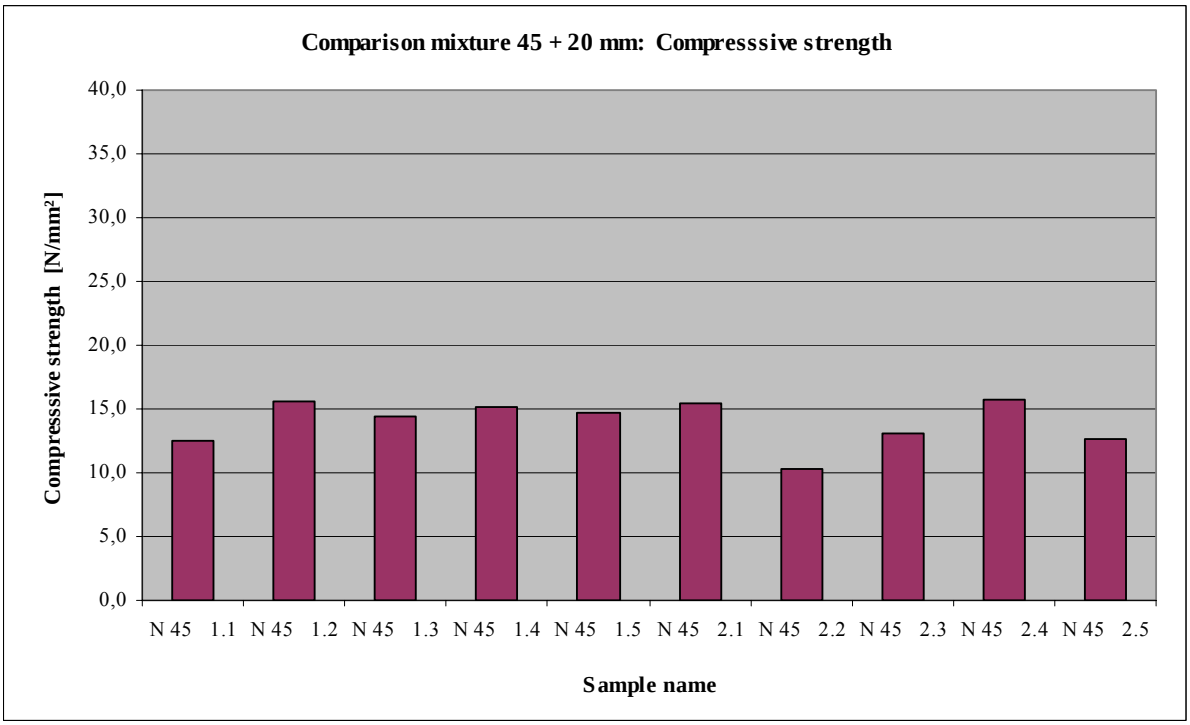


Illustration 26: Compressive strength values – comparison mixture (45 + 20 mm); 2nd ES.

The next table lists the flexural tensile strength values of the comparison mixture from the second experimental series:

Test date	Sample no.	Span	Test speed		Breaking load	Site of fracture		Flexural tensile strength	
						Width	Thickness		Average
		[mm]	[N/mm²*s]	[N/s]	[N]	[mm]	[mm]	[N/mm²]	[N/mm²]
Comparison mixture 65 + 20 mm									
12.08.07	N 65 1.1	318	0.1	50.0	1.947	58.7	44.0	8.2	
12.08.07	N 65 1.2	318	0.1	49.3	1.958	59.4	61.9	4.1	
12.08.07	N 65 1.3	318	0.1	48.0	1.478	59.5	64.2	2.9	6.4
12.08.07	N 65 1.4	318	0.1	54.2	2.245	59.8	45.5	8.6	
12.08.07	N 65 1.5	318	0.1	50.5	2.052	59.8	44.2	8.4	
12.08.07	N 65 2.1	322	0.1	51.4	2.078	59.1	44.2	8.7	
12.08.07	N 65 2.2	322	0.1	48.4	1.600	59.1	39.5	8.4	
12.08.07	N 65 2.3	322	0.1	55.0	2.197	60.7	38.3	11.9	8.3
12.08.07	N 65 2.4	322	0.1	51.5	1.401	59.3	47.8	5.0	
12.08.07	N 65 2.5	322	0.1	49.4	1.556	59.7	40.8	7.6	
Comparison mixture 45 + 20 mm									
12.08.07	N 45 1.1	228	0.1	33.5	1.910	60.5	43.0	5.8	
12.08.07	N 45 1.2	228	0.1	39.6	2.238	59.9	47.1	5.8	
12.08.07	N 45 1.3	228	0.1	39.2	1.814	59.7	46.3	4.8	5.6
12.08.07	N 45 1.4	228	0.1	38.1	1.995	59.7	46.5	5.3	
12.08.07	N 45 1.5	228	0.1	31.8	2.016	59.9	42.9	6.2	
12.08.07	N 45 2.1	240	0.1	38.2	1.518	59.8	48.2	3.9	
12.08.07	N 45 2.2	240	0.1	39.6	1.012	60.2	45.7	2.9	
12.08.07	N 45 2.3	240	0.1	38.5	1.181	60.3	45.7	3.4	3.2
12.08.07	N 45 2.4	240	0.1	39.3	1.424	60.0	47.5	3.8	
12.08.07	N 45 2.5	240	0.1	36.4	576	59.9	43.8	1.8	

Table 15: Flexural tensile strength values; 2nd ES (comparison mixture).

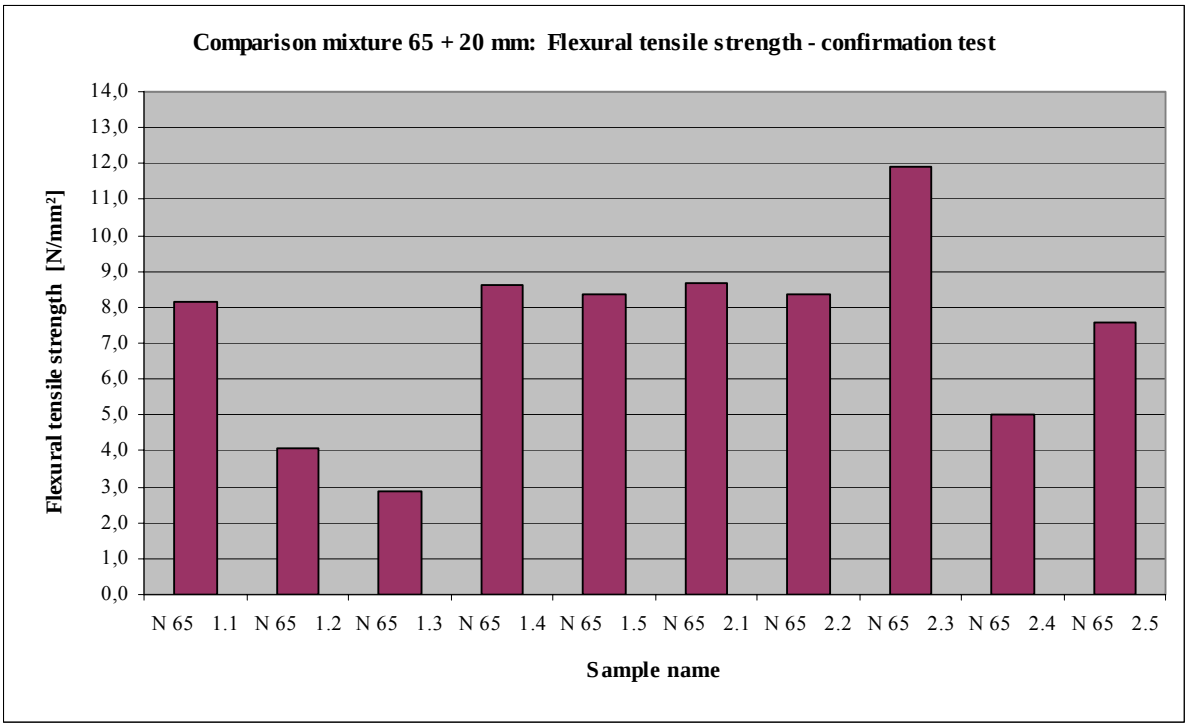


Illustration 27: Flexural tensile strength of the comparison mixture (65 + 20 mm); 2nd ES.

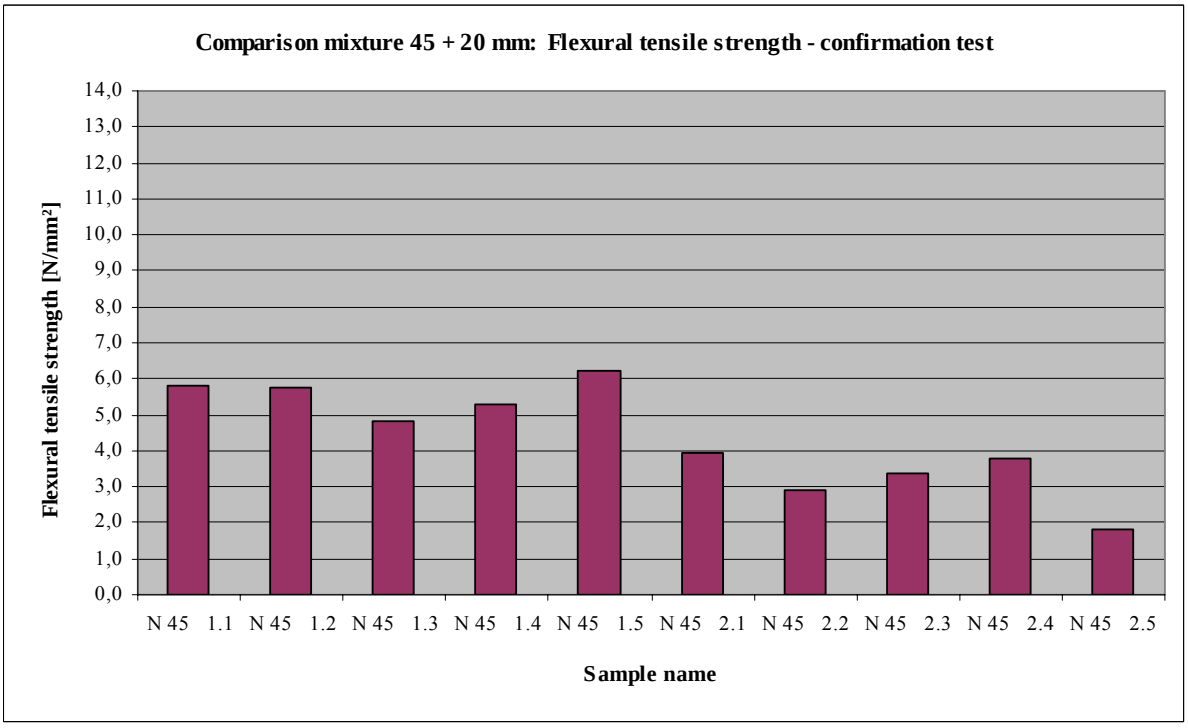


Illustration 28: Flexural tensile strength values of the comparison mixture (45 + 20 mm); 2nd ES.

The compressive strength values of *RenoScreed* were determined in the same way as the comparison mixture. The next table lists the compressive strength values of *RenoScreed*, 2nd ES.

Test date	Sample no.	Width 1	Width 2	Height	Breaking load	Compressive strength	
							Average
		[mm]	[mm]	[mm]	[N]	[N/mm²]	[N/mm²]
RenoScreed 55 + 20 mm							
22.10.07	R 55 1.1	51,0	50,6	52,0	78.102	30,3	
22.10.07	R 55 1.2	50,8	51,0	51,3	82.474	31,8	
22.10.07	R 55 1.3	51,0	51,5	51,1	77.983	29,7	30,8
22.10.07	R 55 1.4	50,9	51,2	51,1	77.051	29,6	
22.10.07	R 55 1.5	50,7	51,1	51,1	84.292	32,5	
22.10.07	R 55 2.1	53,8	53,9	53,4	69.150	23,8	
22.10.07	R 55 2.2	51,4	53,9	54,3	60.905	22,0	
22.10.07	R 55 2.3	53,4	52,9	52,8	85.209	30,2	26,8
22.10.07	R 55 2.4	53,5	53,6	53,7	86.846	30,3	
22.10.07	R 55 2.5	52,7	53,8	52,8	78.104	27,5	
RenoScreed 35 + 20 mm							
22.10.07	R 35 1.1	38,6	38,6	37,1	39.582	26,6	
22.10.07	R 35 1.2	38,8	38,7	35,8	43.494	29,0	
22.10.07	R 35 1.3	38,4	38,3	38,1	38.481	26,2	29,2
22.10.07	R 35 1.4	38,4	38,5	37,4	50.827	34,4	
22.10.07	R 35 1.5	38,4	37,8	37,4	43.576	30,0	
22.10.07	R 35 2.1	34,6	34,2	34,3	31.842	26,9	
22.10.07	R 35 2.2	34,8	34,6	34,4	37.694	31,3	
22.10.07	R 35 2.3	34,7	34,7	34,2	32.471	27,0	28,6
22.10.07	R 35 2.4	34,8	34,8	33,9	39.476	32,6	
22.10.07	R 35 2.5	34,8	34,6	34,6	30.230	25,1	

Table 16: Compressive strength values of the screed slabs; 2nd ES (*RenoScreed*).

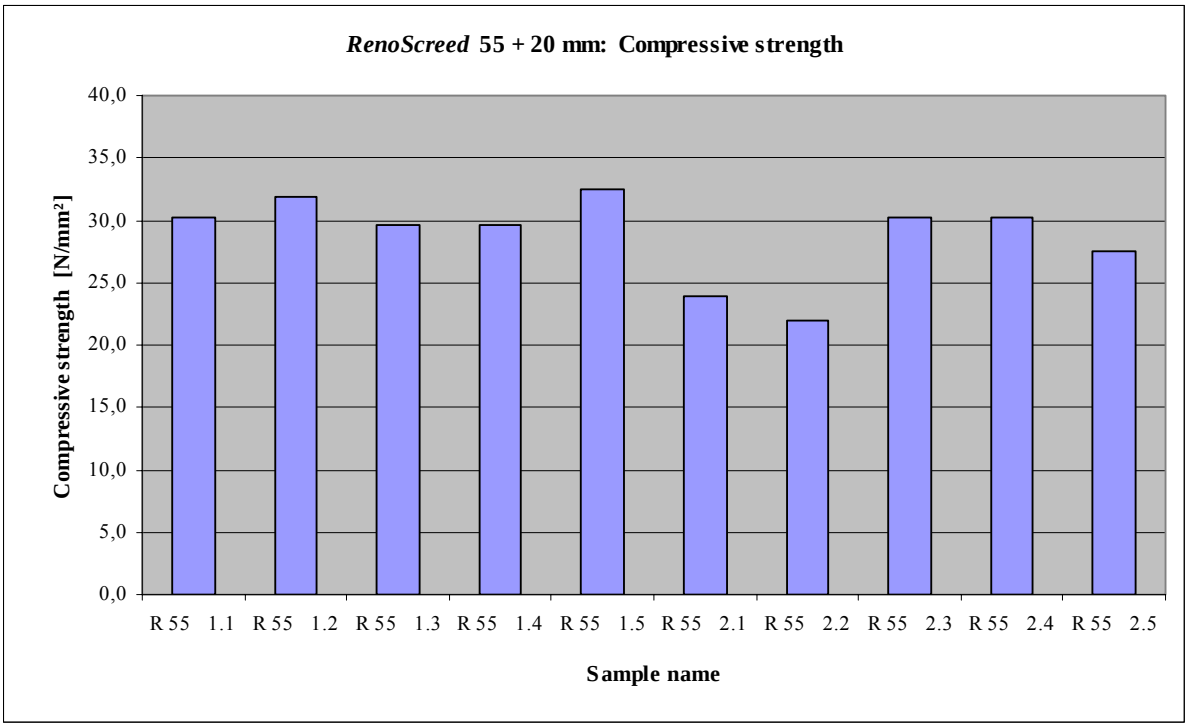


Illustration 29: Compressive strength values of *RenoScreed* (55 + 20 mm); 2nd ES.

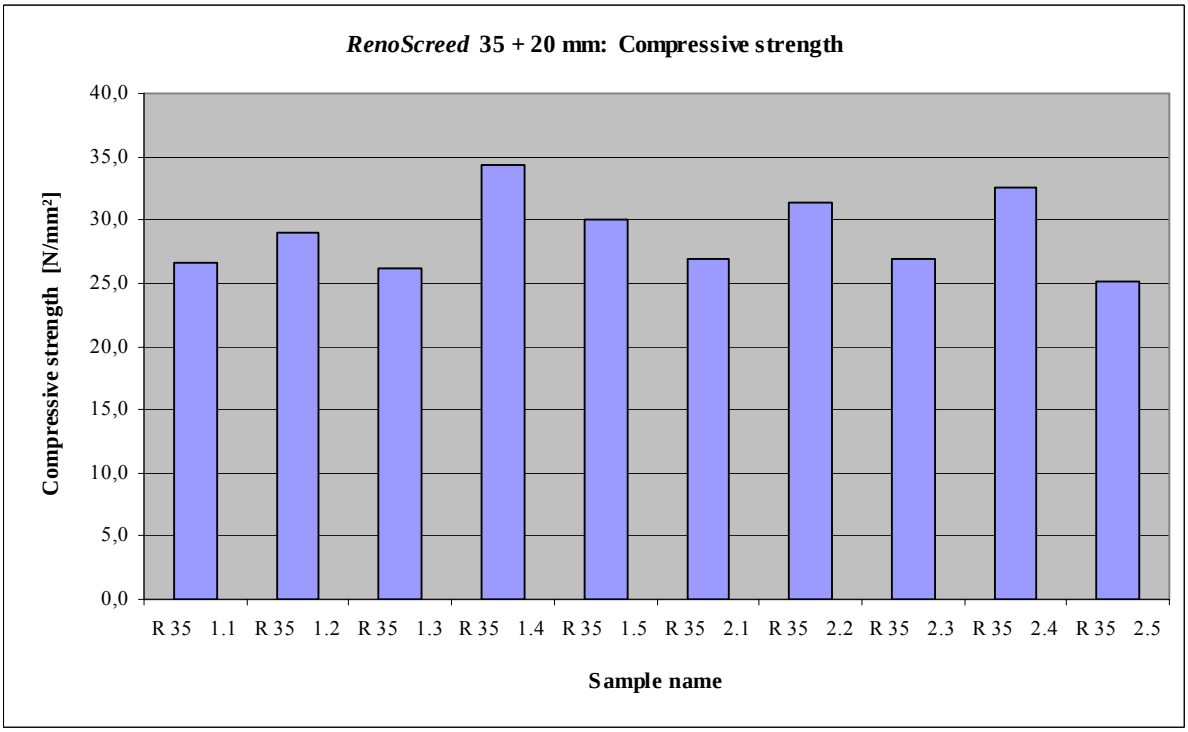


Illustration 30: Compressive strength values of *RenoScreed* (35 + 20 mm); 2nd ES.

The flexural tensile strength values of the *RenoScreed* mixture from the 2nd experimental run are listed in the table below:

Test date	Sample no.	Span	Test speed		Breaking load	Site of fracture		Flexural tensile strength	
						Width	Thickness		Average
		[mm]	[N/mm²*s]	[N/s]	[N]	[mm]	[mm]	[N/mm²]	[N/mm²]
RenoScreed 55 + 20 mm									
23.10.07	R 55 1.1	260	0.1	42.2	1.431	58.7	30.6	10.1	
23.10.07	R 55 1.2	260	0.1	39.9	1.476	59.2	31.1	10.0	
23.10.07	R 55 1.3	260	0.1	40.4	1.769	58.1	30.3	12.9	12.6
23.10.07	R 55 1.4	260	0.1	42.2	1.631	59.6	29.0	12.7	
23.10.07	R 55 1.5	260	0.1	38.7	2.508	57.8	31.1	17.5	
23.10.07	R 55 2.1	264	0.1	43.7	1.859	59.7	25.7	18.7	
23.10.07	R 55 2.2	264	0.1	41.1	1.249	60.3	25.9	12.2	
23.10.07	R 55 2.3	264	0.1	42.6	3.922	60.0	52.7	9.3	15.2
23.10.07	R 55 2.4	264	0.1	40.5	3.380	60.5	29.6	25.2	
23.10.07	R 55 2.5	264	0.1	44.0	4.397	59.9	53.0	10.3	
RenoScreed 35 + 20 mm									
22.10.07	R 35 1.1	171	0.1	31.5	2.144	59.4	36.4	7.0	
22.10.07	R 35 1.2	171	0.1	28.3	1.508	60.0	30.6	6.9	
22.10.07	R 35 1.3	171	0.1	22.4	1.488	60.5	30.3	6.9	6.2
22.10.07	R 35 1.4	171	0.1	32.2	1.459	60.0	36.7	4.6	
22.10.07	R 35 1.5	171	0.1	23.5	1.232	60.0	31.1	5.5	
23.10.07	R 35 2.1	176	0.1	26.9	1.754	59.8	34.0	6.7	
23.10.07	R 35 2.2	176	0.1	25.2	1.286	59.8	33.5	5.0	
23.10.07	R 35 2.3	176	0.1	28.3	1.583	59.9	34.9	5.7	5.9
23.10.07	R 35 2.4	176	0.1	30.7	1.643	59.4	36.9	5.4	
23.10.07	R 35 2.5	176	0.1	29.0	1.832	59.9	35.1	6.5	

Table 17: Flexural tensile strength values; 2nd ES (*RenoScreed*).

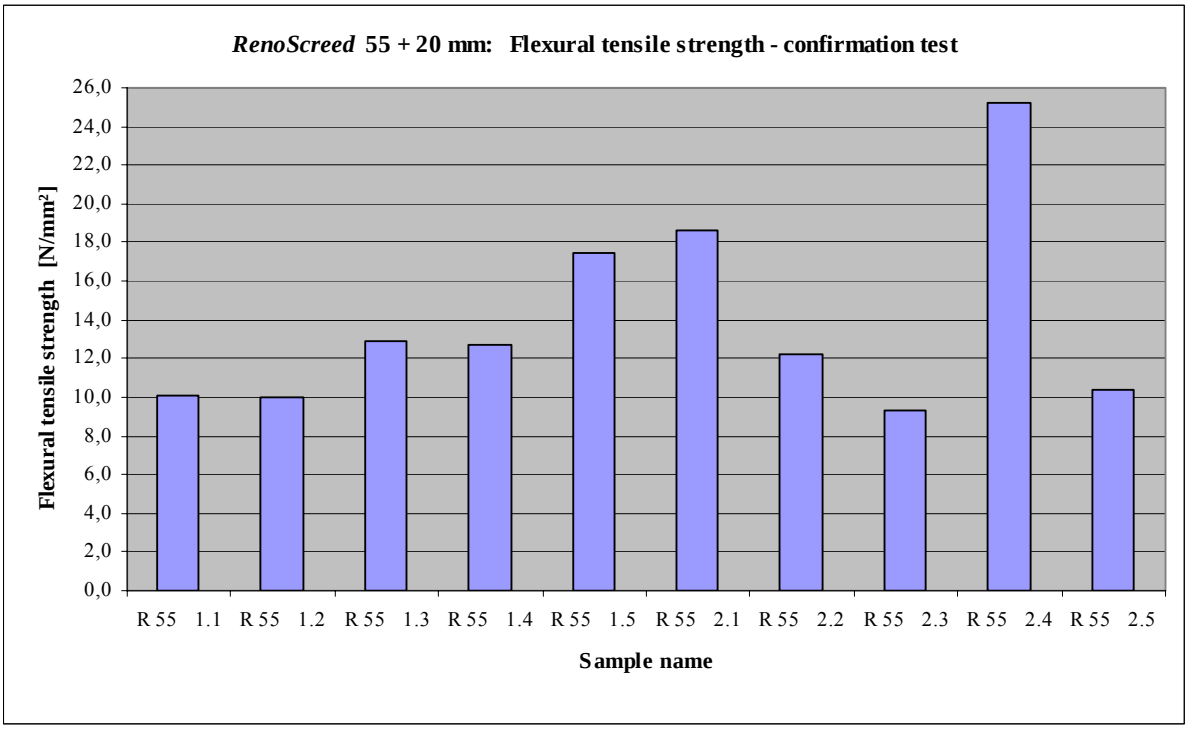


Illustration 31: Flexural tensile strength values of *RenoScreed* (55 + 20 mm); 2nd ES.

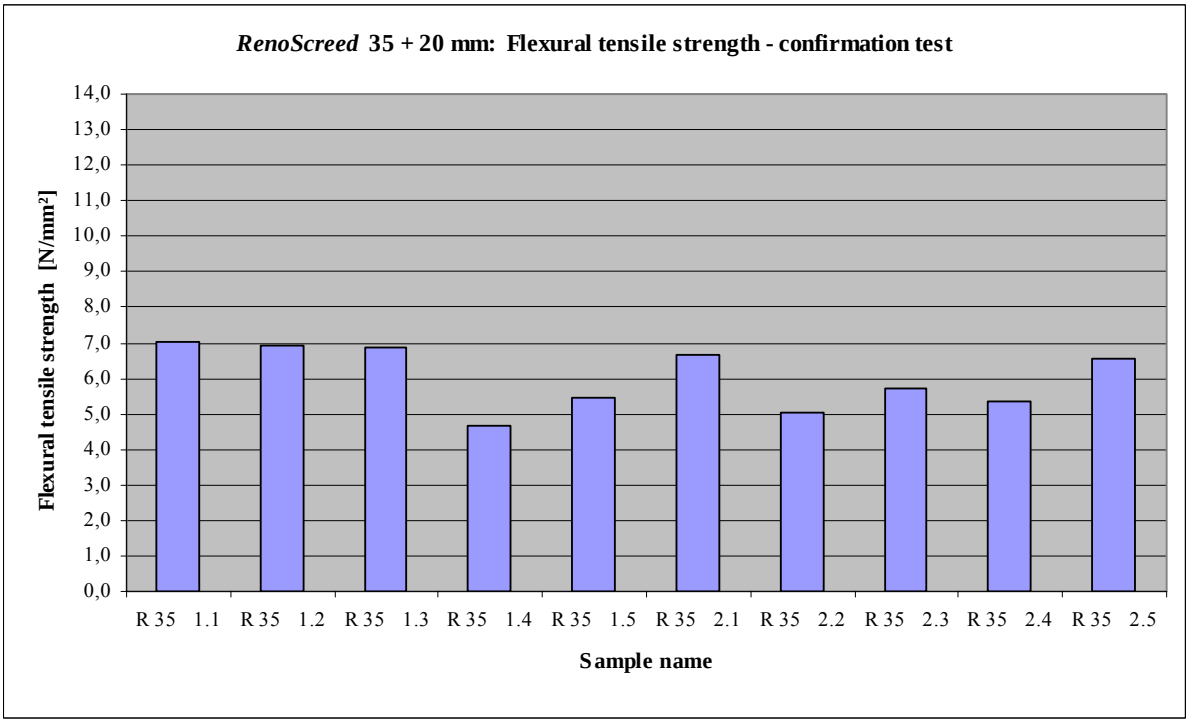


Illustration 32: Flexural tensile strength values of *RenoScreed* (35 + 20 mm); 2nd ES.

	Density [kg/dm³] (1st ES and 2nd ES)
Comparison mixture	2.01 … 2.05
RenoScreed	2.09 … 2.22

3.7. Surface quality (surface tensile strength values, scratch tests, absorbing capacity)

For the determination of the *surface tensile strength* three steel dollies were glued to the surface of each sample area after the edge curling measurement.

The test results are listed in the table below.

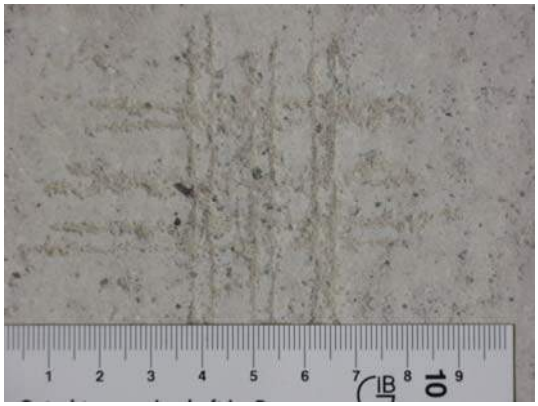
Test series	Area	Mixture	Thick-ness	Test dolly 1 [N/mm²]	Test dolly 2 [N/mm²]	Test dolly 3 [N/mm²]	Average [N/mm²]
1	1	*RenoScreed*	35	2.07	1.95	1.17	1.73
1	2	Comp. mixt.	35	0.31	0.33	0.67	0.44
2	1	*RenoScreed*	55	1.85	2.15	0.81	1.61
2	2	*RenoScreed*	35	2.34	1.08	1.91	1.78
2	3	Comp. mixt.	65	0.15	0.35	0.31	0.27
2	4	Comp. mixt.	45	0.19	0.13	0.05	0.13

Table 26: Surface tensile strength values of all sample areas – all fractures within screed structure (see photos below)

RenoScreed Comparison mixture

In addition, *scratch tests* were carried out on the surfaces. The results are shown in the photos below.

RenoScreed



Comparison mixture

After the scoring it is assessed how deep the scratches are and whether the edges are broken out at the intersections. Normally, the orthogonal scratch pattern does not lead to deep scratches in conventional cementitious screeds. The scratches can be seen but they are usually hardly palpable. As a rule, the diagonal scratch pattern leaves broken out edges which often leads to misinterpretations. Since there are no valid standards a lot of experience is necessary to judge the result of scratch tests in the correct way.

Sample areas produced with *RenoScreed* showed remarkably good results without "*sintered layers*" on the surface, whereas the comparison mixture showed fairly poor and partially insufficient results.

The surface of the screeds installed with the comparison mixture showed an evidently higher water *absorbing capacity* than those installed with *RenoScreed* mortar. Still, the absorbing capacity of *RenoScreed* is sufficient for the application of aqueous primers and adhesives.

3.8. Drying period of the sample areas

According to valid standards a screed can be covered as soon as the residual moisture value falls below 2.0 CM-%. The measurement is carried out in compliance with procedure instruction "FBH-AD" from February 2005 [5.8.]. The value is to be determined ten minutes after shutting the CM-tester. The results are influenced by factors such as relative humidity above the screed before the test, position of the sample piece within the screed (drier values at the edges), share of pebbles in the sample piece etc.

The measurements showed the following drying times for the mixtures in question:

– Standard mixture: more than **56 days**
– RenoScreed: **7 days**

3.9. Assessment of the additional screed strips with an unfavourable length- width- ratio

Screed strips with unfavourable length-width-ratios are prone to crack development if the screed strength is high. In order to test the tendency toward crack development of the screed mixtures used, a screed strip of 0.3 x 2.0 m (produced from the *RenoScreed* mixture) was placed into a shutter specially manufactured for this purpose. During the entire test period no cracks were found in this screed strip.

The conclusion to be drawn from this is that at an early stage the mortar applied does not show any detrimental tensions. That is to say the screed strength develops much faster than the inherent tensions caused by the drying and the contraction of the mortar. As a result any unfavourable crack developments are avoided.

3.10. Flatness tolerances on the sample areas according to DIN 18202

The flatness of the sample areas was examined with the help of a measuring rod of 2.0 m length. All sample areas met the requirements according to DIN 18202, table 3, line 4 (i.e. floors with finished surfaces, elevated demands). All flatness variations measured with the above mentioned measuring rod were below 5.0 mm. The distance between the two points of measurement amounted to 2,0 m.

Within a testing period of 52 days the edge curling on the sample areas amounted to a maximum of 2.0 to 3.0 mm in relation to the original surface heights. Edge curling, however, is not subject of DIN 18202.

3.11. Granulometric composition of the mineral aggregate

When the mineral aggregate was delivered, a sample was taken to determine the granulometric composition. The following graphs show the grain size distribution curve of the mineral aggregate.

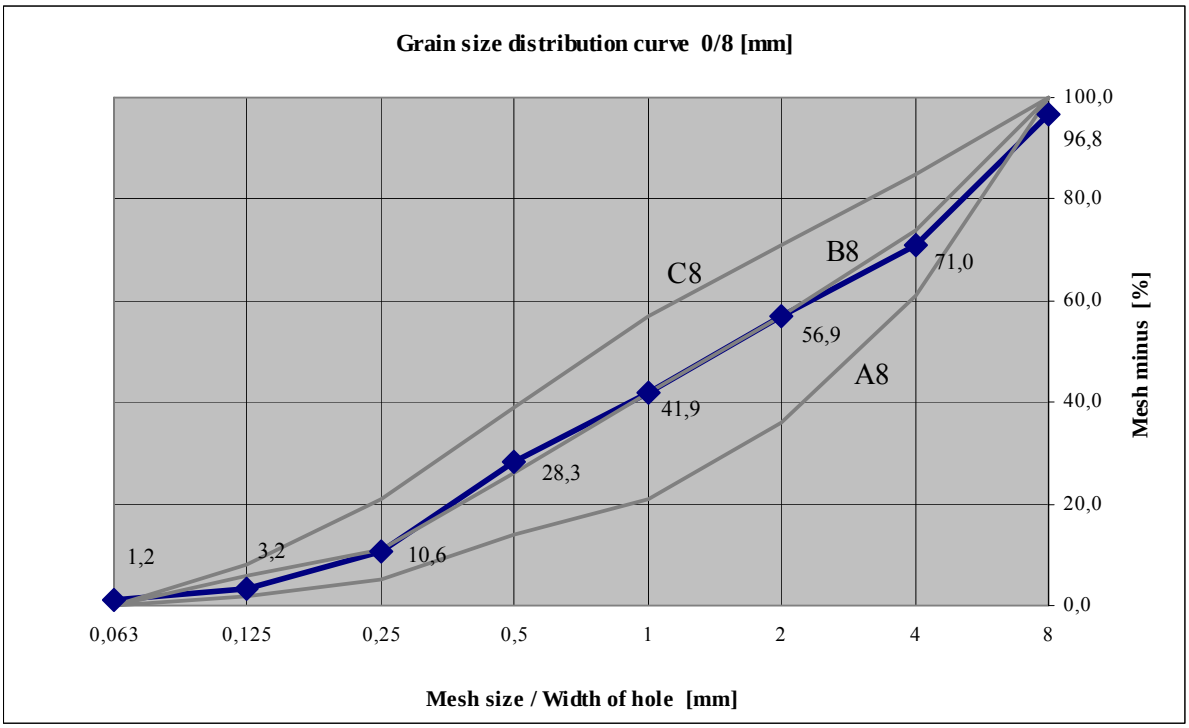


Illustration 45: Grain size distribution curve of the mineral aggregate; 1st ES;
A8, B8, C8: grain size distribution curves according to DIN 1045 [5.1.].

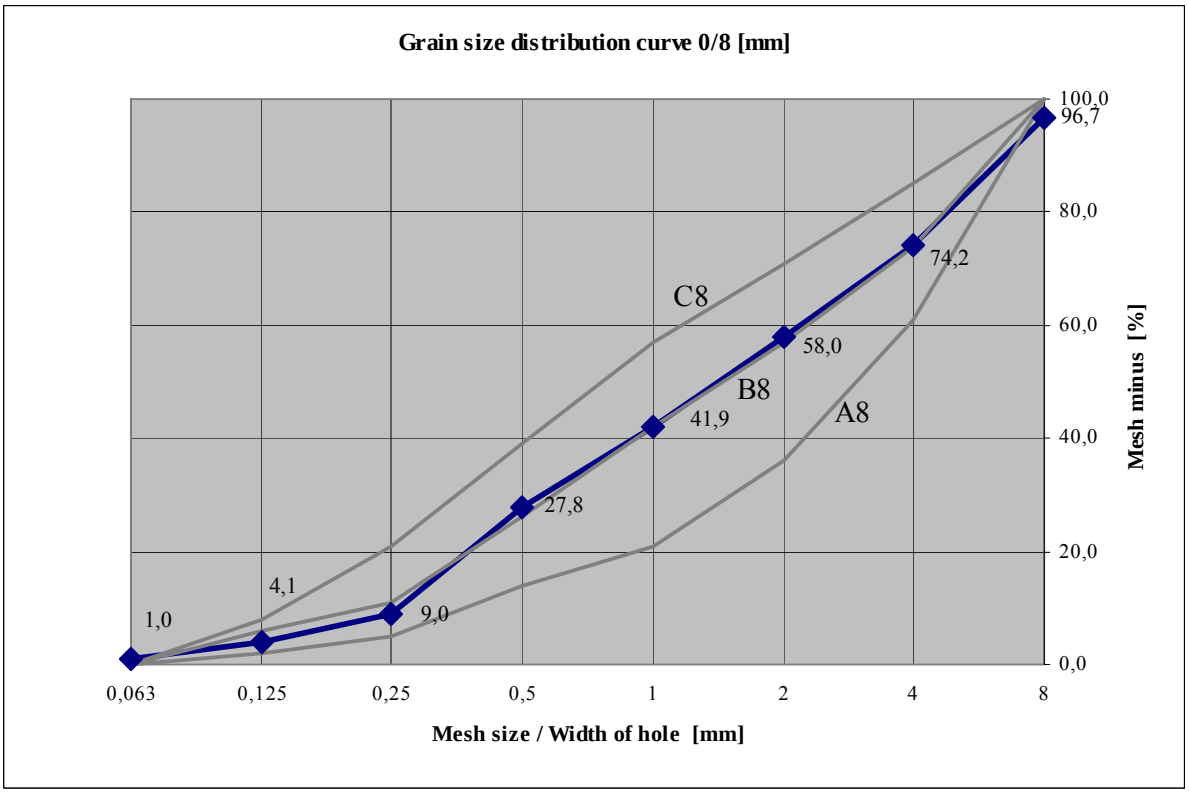


Illustration 46: Grain size distribution curve of the mineral aggregate; 2nd ES.;
A8, B8, C8: grain size distribution curves according to DIN 1045 [5.1.].

In both series the mineral aggregate met the requirements of the grain size distribution "Type B" according to DIN 1045 [5.1.].

3.12. Trafficability

A screed is supposed to be trafficable after reaching a compressive strength value of at least 15 N/mm² [5.6.]. *RenoScreed* reached this value after 24 hrs., the comparison mixture after 3 days.

4. General evaluation and summary

The tests demonstrate that screeds produced with the *RenoScreed* mixture generally hardened significantly faster and showed less shrinkage than the comparison mixture. With *RenoScreed* the usual edge curling deformation set in at a considerably earlier date than with the comparison mixture, which was produced simultaneously using a common screed mortar composition.

Due to their mortar composition and their more opportune water-cement ratios, the screeds produced with *RenoScreed* showed much higher strength values and the final strength was reached earlier.

After three days, screeds produced with the *RenoScreed* mixture showed strength values which a screed manufactured with the comparison mixture first reached after 28 days.

5. References

5.1. DIN 1045-2:2001-07 :
”Concrete, reinforced and prestressed concrete structures”;
Part 2: Concrete - Specification, properties, production and conformity;
Application rules for DIN EN 206-1; Amendment A2; att. doc. L

5.2. DIN 18202:2005-10 : „Tolerances in building construction; Buildings”

5.3. DIN 18560-1:2004-04 : “Floor screeds in building construction”;
Part 1: General requirements, testing and construction

5.4. DIN 18560-1:2004-04 : “Floor screeds in building construction”;
Part 2: Floor screeds and heating floor screeds on insulation layers

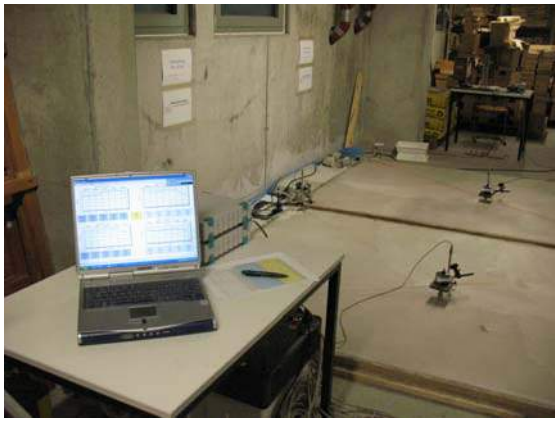
5.5. DIN EN 13892:2003-02: „Methods of test for screed materials”

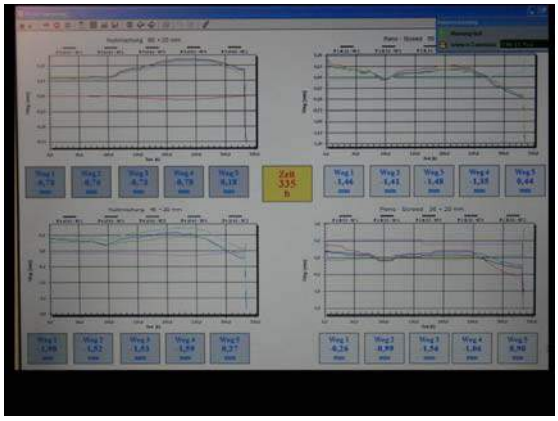
5.6. DIN 18560, Part 1 and 2: “Floor screeds in building construction“; Mai 1992

5.7. BEB-Hinweisblatt: „Oberflächenzug- und Haftzugfestigkeit von Fußböden
– Allgemeines, Prüfung, Einflüsse, Beurteilung“; November 2004

5.8. BEB-Merkblatt: „Schnittstellenkoordination bei beheizten Fußbodenkonstruktionen
– Arbeitsanweisung/Dokumentation FBH-AD CM-Messung“; February 2005

6. Photo report






SCHWENK
ZEMENT
Portlandzement
EN 197-1
CEM I 32,5 R
25 kg


PZ
25kg
PORTLANDZEMENT
CEM I 42,5R
Portland-Zementwerke GmbH & Co. K
Anhofen / Bayern