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zertifiziert nach
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Test report PB 18120 U*)

Client/manufacturer:	ETS Europe BVBA Herentalsebaan 406/Unit D1 Belgium, 2160 Wommelgem
Order:	Comparative studies of the chemical resistance of mortar products
Description of products:	Material: ETS ECO SIL and a commercially available mortar for sewerage systems
Responsible persons:	Dipl.-Ing. Thorsten Hagedorn Michaela Jargosch
Equipment:	Media test stand / mortar testing machine
Delivery date:	10/04/2012 – 24/04/2012
Test period:	Mai 2012 until July 2012

This report consists of 7 pages including cover sheet.

*) These test report is a transcription of test report 1253 from the 06.09.2012. Changes are the new client designation and the new product name for the tested material.

Weimar, 06.11.2018

Dr.-Ing. Ulrich Palzer
Director of the Institute

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Head of Testing, Certification and Monitoring Body

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Person in charge

1 Task

The IAB - Weimar Institute of Applied Construction Research conducted comparative analyses for the chemical resistance of the product ECO SIL and a commercially available mortar for sewerage systems (called SBM in this report).

The chemical attack should be realized by a permanent exposure in a mixture of lactic acid and acetic acid with a pH value of 3.0 for 70 days. This acid attack corresponded with the load on mortar and concrete in agricultural constructions.

There was a parallel exposure of reference prisms in water and indoor climate.

2 Experimental procedure

2.1 General information

All basic materials were delivered by the client. The mortars were mixed according to the manufacturer's instructions and filled into prismatic shapes. The produced prisms were standardized prisms with a dimension of 4 x 4 x 16 cm^3.

After hardening in the prism shapes the test specimens were demoulded, covered and stored at a humidity of 95 % r. h. until the time of testing.

According to the principal the ECO SIL prisms should be 14 days and the SBM prisms should be 28 days before starting the test.

The allocation of prisms was as follows:

ECO SIL

- Prisms/specimens 1-6: acid exposure
- Prisms/specimens 7-12: water exposure
- Prisms/specimens 13-18: indoor climate

SBM

- Prisms/specimens 1-6: indoor climate
- Prisms/specimens 7-12: water exposure
- Prisms/specimens 13-18: acid exposure

Respectively 8.64 l test medium of every six prisms were used to reach a surface to volume ratio of 20 m^{-1}.

The acid mixture was composed as follows:

Mixture of lactic acid and acetic acid: 85 weight % lactic acid (80 % acid) + 15 weight % acetic acid (5 % acid) } pH value = 3.

The exposure temperature was kept constant at 20 °C. The test solutions were continually mixed, regularly monitored (pH value, temperature, amount) and adjusted if necessary. Furthermore, the test media were replaced weekly.

2.2 Test parameters

Additionally to the acid exposure two reference storages were conducted.

Prior to the exposure of the specimens in the different test solutions the weight, the dimensions and the saturated density were determined. The mass changes of prisms in acid solution were determined weekly.

On all prisms following parameters were determined after an exposure period of 70 days:

- Weight
- Dimension
- Density (wet)
- Flexural strength
- Neutralization depth (indicator solution: Phenolphthalein)
- Compressive strength.

Therefore a comparison between the measured parameters of prisms of different treatments was possible.

3 Results

3.1 Mass changes

The acid mixture was replaced weekly and thereby the masses of specimens were determined. In (Figure 1) was shown the changes of specimen masses of every single prism of ECO SIL.

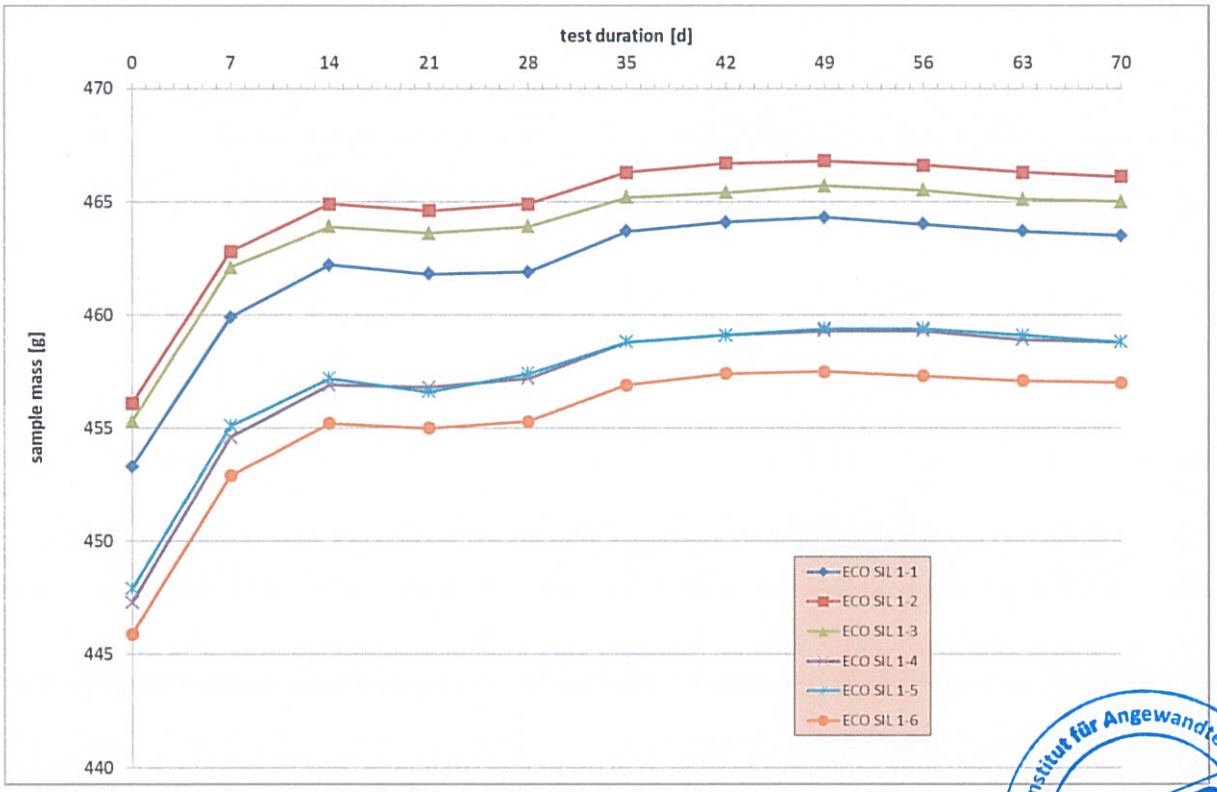

Figure 1: Mass change of prisms (ECO SIL) in the acid mixture over the test duration

All six test specimens had a similar increase in mass. The mean increase in mass in the acid exposure was 2.3 %.

The mass increase of the prisms at the start of the test was caused on the pre-storage of prisms that means that the prisms were not completed saturated at the start of the test.

In (Figure 2) was shown the individual profiles of mass changes of mortar prisms for sewerage systems (SBM 13-18). Here again was the mass increase of prisms at the start of the test caused on the pre-storage of prisms. After the half of the exposure time there was a beginning decrease of prisms mass (dissolution processes on the PK-surfaces) detectable.

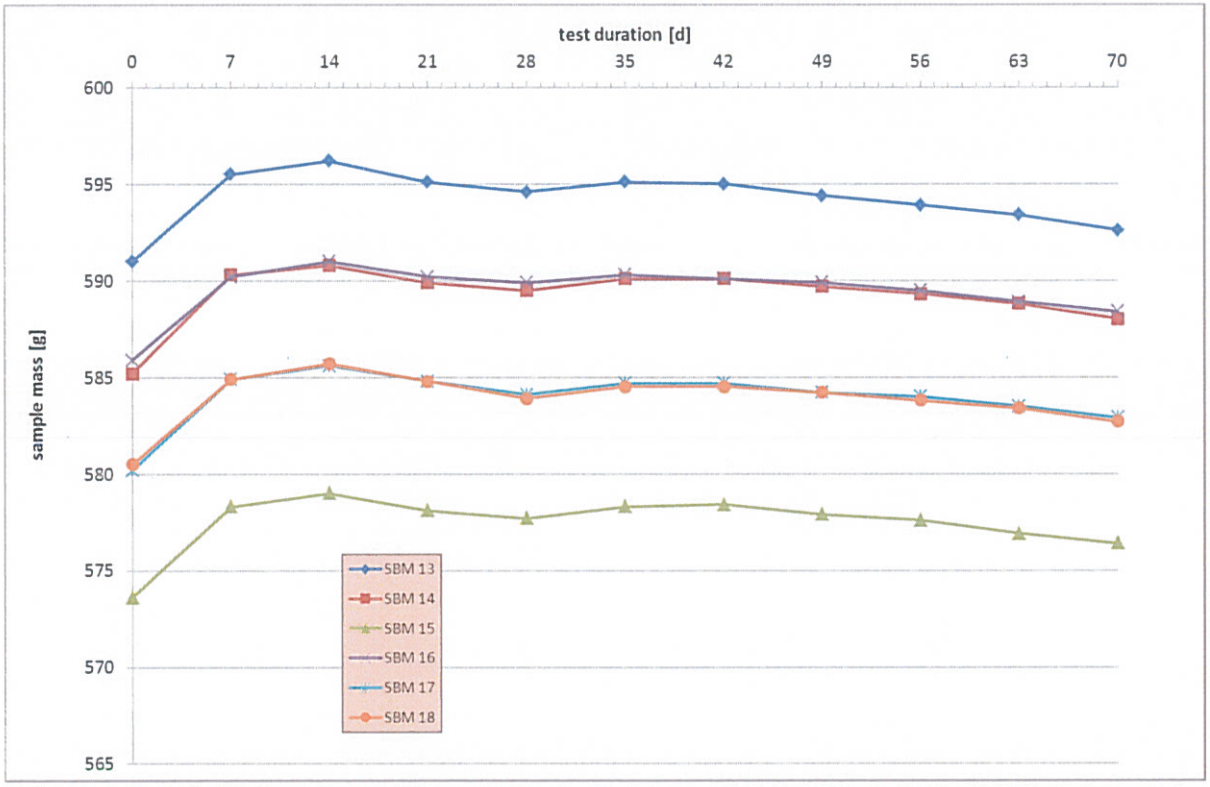

Figure 2: Mass change of prisms (SBM) in the acid mixture over the test duration

For a better comparison the series averages of individual mortar mixes were normalized and shown in (Figure 3). These test conditions led to a mass loss of mortar prisms for sewerage systems (SBM) rather than for ECO SIL prisms.

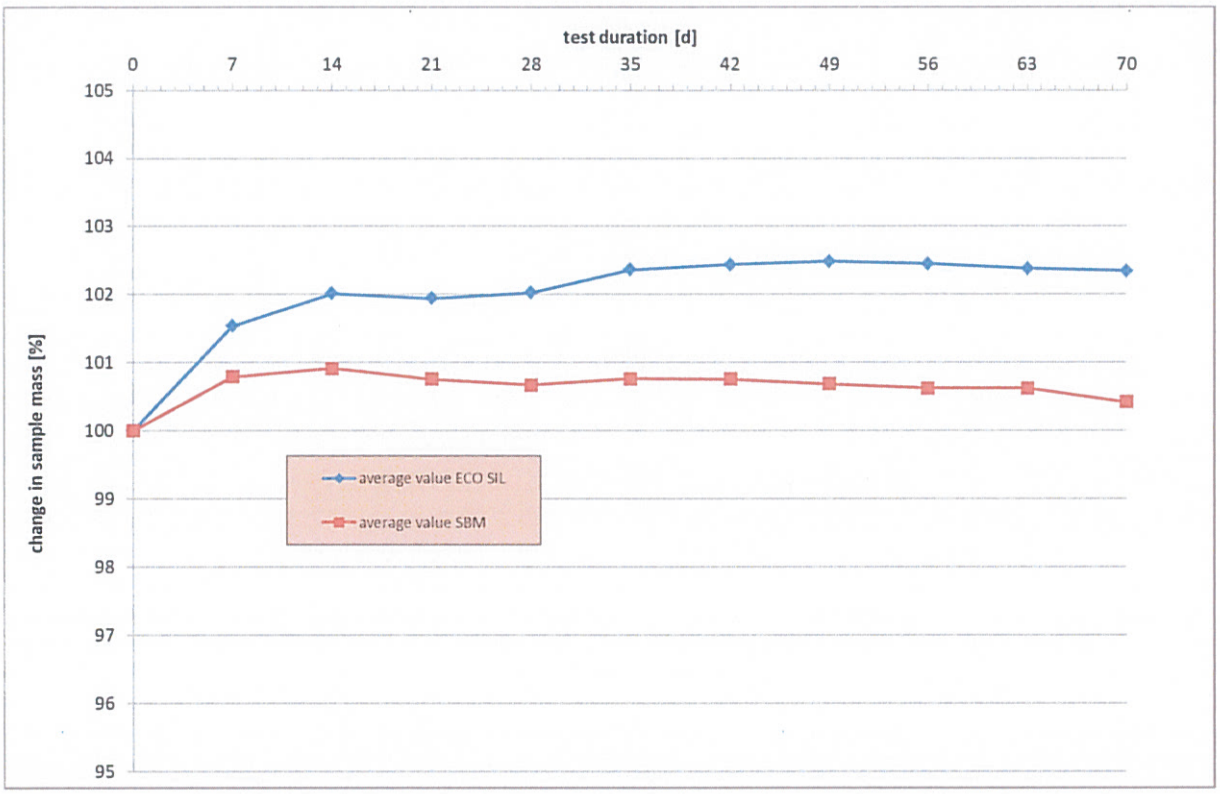

Figure 3: Normalized mean average of mass change of mortar series in the acid mixture over the test duration

3.2 Densities, strength, neutralization depths

After 70 days, the end of the exposure time, on all prisms the mentioned parameters were determined. As a reference the prisms of the water exposure were chosen because this exposition corresponds better to the practical application of the mortars than the storage in indoor climate 20/65. In Table 1 to Table 4 were shown the determined values, divided by the exposure types.

Table 1: Measured values of densities (wet)

Exposure	Acid		Water		Indoor climate	
Mortar type	Density start [g/cm³]	Density end [g/cm³]	Density start [g/cm³]	Density end [g/cm³]	Density start [g/cm³]	Density end [g/cm³]
ECO SIL	1.80	1.84	1.80	1.84	1.79	1.67
SBM	2.21	2.21	2.21	2.23	2.21	2.14

Table 2: Measured values of strength

Exposure	Acid		Water		Indoor climate	
Mortar type	Flexural strength [MPa]	Compres-sive strength [MPa]	Flexural strength [MPa]	Compres-sive strength [MPa]	Flexural strength [MPa]	Compres-sive strength [MPa]
ECO SIL	4.91	51.5	5.92	52.5	6.04	48.5
SBM	5.48	44.1	6.34	54.3	6.33	51.9

Table 3: Residual strength after acid exposure compared to water exposure

Mortar type	Flexural strength [%]	Compressive strength [%]
ECO SIL	83	**98**
SBM	86	**81**

Table 4: Neutralization depths

Exposure	Acid	Water	Indoor climate
Mortar type			
ECO SIL	0.8 mm	0.0 mm	0.0 mm
SBM	0.6 mm	0.0 mm	0.8 mm

Based on the measured values following points were noted:

The densities of both mortar systems before and after the acid exposure respectively water exposure behaved in the same way (Table 1).

Both mortar types showed a similar residual flexural strength compared to the reference exposure (Table 3).

After acid exposure the mortar type ECO SIL showed a significant higher residual compressive strength (in comparison with the reference storage) than the mortar type SBM (Table 3).

In the opposite to mortar type SBM in mortar type ECO SIL there was no neutralization of specimen`s cross-section detectable (Table 4, Figure 4 and Figure 5) after a storage in indoor climate of 70 days.

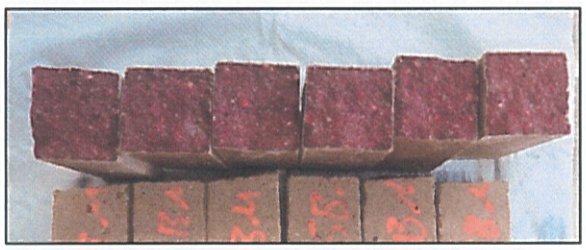

Figure 4: SBM prisms after acid exposure

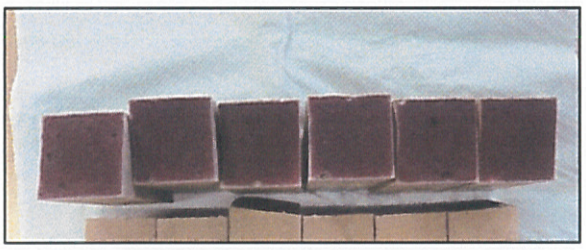

Figure 5: ECO SIL prisms after acid exposure

After acid exposure the SBM prisms (mortar for sewerage systems) showed a slightly yellow discoloration on the bottom side (Figure 6).

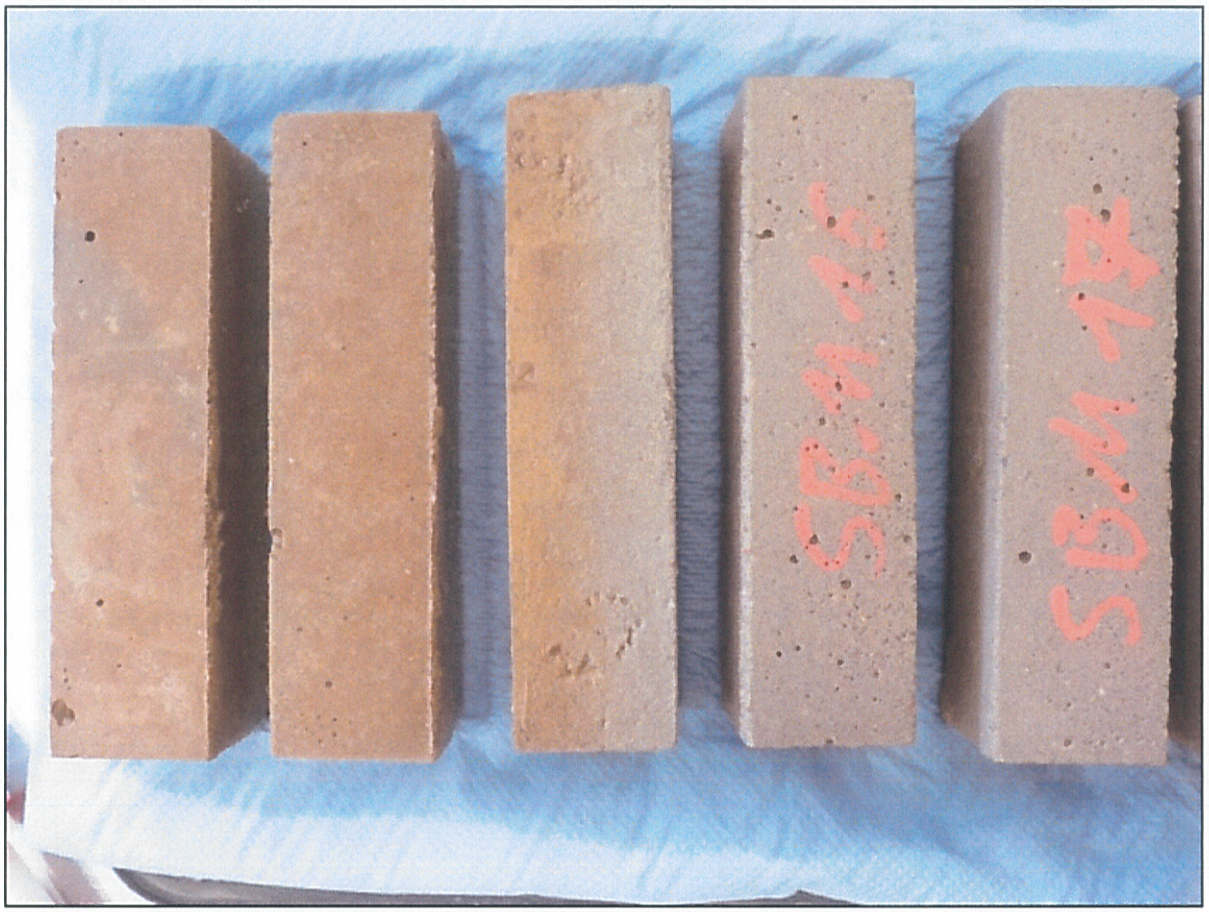

Figure 6: Discoloration of the SBM prisms after the acid exposure

4 Conclusions

The IAB - Weimar Institute of Applied Construction Research conducted studies for chemical resistance of two mortar products for the client ETS Europe BVBA. The used test medium should adjust a chemical attack as it can be found in agricultural constructions (for example in silage facilities) or in biogas plants. Therefore, the samples were exposed to a mixture of lactic acid and acetic acid at a pH value of 3.0. 70 days was the test duration, based on the standardized "Sielbaurichtlinie". At the same time there were reference storages of prisms in indoor climate and in water.

As a result it can be appear that the mortar type ECO SIL compared to the SBM mortar showed a higher resistance under the selected test conditions. These were shown in a much higher residual compressive strength after acid exposure compared with the respective water exposure. Furthermore, there was a beginning mass loss of SBM prisms stored in acid mixture (dissolving acid attack) compared with no significant mass loss of ECO SIL prisms.

After 70 days an additionally positive effect was found on prisms stored in indoor climate. No neutralization of edge regions as a result of carbonation was detectable on the ECO SIL prisms in contrast to the SBM prisms (commercially available mortar for sewerage systems).

The results refer exclusively to the specimens which were tested.

End of report.

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