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Testing of Specialfog byggplast

(2 appendices)

This is a translation from the Swedish original document. In the event of any dispute about the content of the document, the Swedish text shall take precedence.

This is a revised version of the original report 7F005469. Changes has been made to further clarify the results and the conclusion. Changes have been made in chapters Assignment and Conclusion and discussion.

Assignment

Testing of Specialfog Byggplast from ESSVE according to SP-method 1380 version 3. A test of the dimensional stability of the joint sealant according to SP-method 5138 was also performed. The purpose of the testing was to investigate whether Specialfog Byggplast works just as well as tape when used for splicing air and vapour barriers inside walls.

Samples

Tubes with Specialfog Byggplast was sent to RISE for testing. Two deliveries arrived at RISE as a lot of material was used during the tests.

The samples arrived at RISE at these dates;

- Two tubes arrived at RISE in April 2017.
- Two more tubes arrived at RISE in August 2017. Batch 219346. Production date 21.06.17.

Testing procedure

Dimensional stability according to SP-method 5138

The test was performed according to a modified version of SP-method 5138. Originally this method has been developed for the testing of tapes, but it was performed as well as it could be made in this case.
Two pieces of an air and vapour barrier with dimensions 75±1 cm x 20±1 cm were jointed together by using Specialfog byggplast of a length of 70±1 cm according to instructions in SP-method 1380. The direction of the joint was orthogonal to the production direction of the air and vapour barrier. The air and vapour barrier that was used was a 0.20 mm thick Dampspærre 50 from Isola, certificate nr. 0207/07, Order 4024925-2017. The joint sealant was from batch 219346. The joint was made according to instructions from the customer (final thickness of 4 mm, which demanded a rather large amount of joint sealant for each splice which made it quite difficult to control the final width of the joint). A string of the joint sealant of approximately 8 mm thickness was placed on one air and vapour barrier where after another air and vapour

barrier was placed on top of the string and a rolling weight of 2 kg was rolled back and forth two times along the splice pressing the joint sealant to a thickness of approximately 4 mm. The width of the pressed joint sealant became between 20 and 30 mm. Lines were drawn at both ends of the joint sealant to see the difference of the dimensional stability of the joint sealant and the air and vapour barrier.

The samples were left to cure at 23 °C/50 %RF before the exposure. To facilitate the curing of the joint sealant, spacers were needed between the two air and vapour barriers of the joint so that it was not tight between them. The exposure lasted for 7 days. During the first day the temperature was ramped up linearly from 23 °C to 65 ± 2 °C, where after the temperature was kept constant at 65 ± 2 °C for five days. The last day a linear ramp of the temperature down to 23 °C was performed. After exposure the samples were conditioned for at least 24 hours before visual examination and control of the dimensional change of the air and vapour barrier.

Testing according to SP-method 1380 version 3.
Testing of the joint sealant was performed according to SP-method 1380 version 3, where the following tests were performed;

5.2 Material composition (analysis with FTIR), accredited method
IR spectrums were collected with a FTIR equipment with an ATR accessory. Two spectrums were collected on the material, for each spectrum a new sample was used. The measurement was performed on a small amount of joint sealant that had been smeared out on the ATR crystal. Each spectrum was collected between 4000 and 400 cm^{-1} with 32 scans and Atmospheric suppression and has been ATR corrected.

5.4 Tensile strain at break
Performed according to SP method 1380 version 3.

5.5 Shear test
Performed according to SP method 1380 version 3.

5.6 Water vapour transmission resistance test
Water vapour transmission resistance of the splices, part 5.6 and 5.7.3 in SP-method 1380 version 3, was performed according to standard EN 1931 method B.

The temperature and the humidity were 23±1 °C respectively 75±2 %RH on the outside of the sample cups. In each sample cup $CaCl_2$ was used as desiccant, the climate in the sample cups were 23±1 °C and 0 %RH (on the dry side). The test was performed with splices that had been produced on 2017-10-06 and after that had been left to cure in 23 °C/50 %RH during the time the ageing test was performed.

5.7 Heat ageing
The heat ageing was performed at 90 °C. 90 °C corresponds to the heat ageing that is performed according to SPF verksnorm 2000/2001 and SP CR 128 Attachment 1. The ageing was performed between 2018-01-17 and 2018-07-04.

5.7.1 Tensile strain at break after ageing
Performed according to SP method 1380 version 3.

5.7.2 Shear test after ageing
Performed according to SP method 1380 version 3.

5.7.3 Water vapour transmission resistance test after ageing
Testing performed according to method described in 5.6 Water vapour transmission resistance test.

The same air and vapour barrier was used for these tests as in the testing of the dimensional stability. The splices were made according to instructions from the customer, so the width of the joint sealant in these samples were also between 20 and 30 mm.

The splice samples were kept in 23 °C/50 %RH before the ageing was started and before testing after complete ageing exposure. To facilitate the curing of the joint sealant, spacers were needed between the two air and vapour barriers of the joint so that it was not tight between them.

Results

Dimensional stability according to SP-method 5138
Requirement; The length of the jointing material must not change more than 0.5 % on the air and vapour barrier, and no leakages (channels) are allowed between the tape and the underlay.

Results;
No channels between the joint sealant and the air and vapour barrier could be seen. It must be mentioned, however, that the samples have been significantly affected by the exposure, which is especially seen by cracks that has appeared in the joint sealant and that bubbles have appeared between the joint sealant and the air and vapour barrier. See pictures below. The bubbles seemed not to be as wide as the joint, so a leakage test was not performed. The appearance of cracks and bubbles are more discussed in the part where the behaviour of the joint sealant during curing and ageing is discussed.
The requirement that the change in length of the jointing material must be less than 0.5% is intended for single-sided splicing tapes, so it is hard to use that requirement for this product as it is hard to measure the change in length of a joint sealant. The difference to the change in length of the air and vapour barrier (see Table 1) was judged to be small when the samples were examined, and the change in length of the air and vapour barrier was measured to be between 0.1 and 0.2 %, so the change in length of the joint sealant was estimated to be close to that value.

Table 1. Dimensional stability of air and vapour barrier

	Before (mm)	After (mm)	Difference (mm)	Difference (%)
Sample 1	71.60	71.65	0.05	0.1
	71.50	71.50	0.00	0.0
Sample 2	71.65	71.80	0.15	0.2
	71.80	71.95	0.15	0.2
Average				0.1

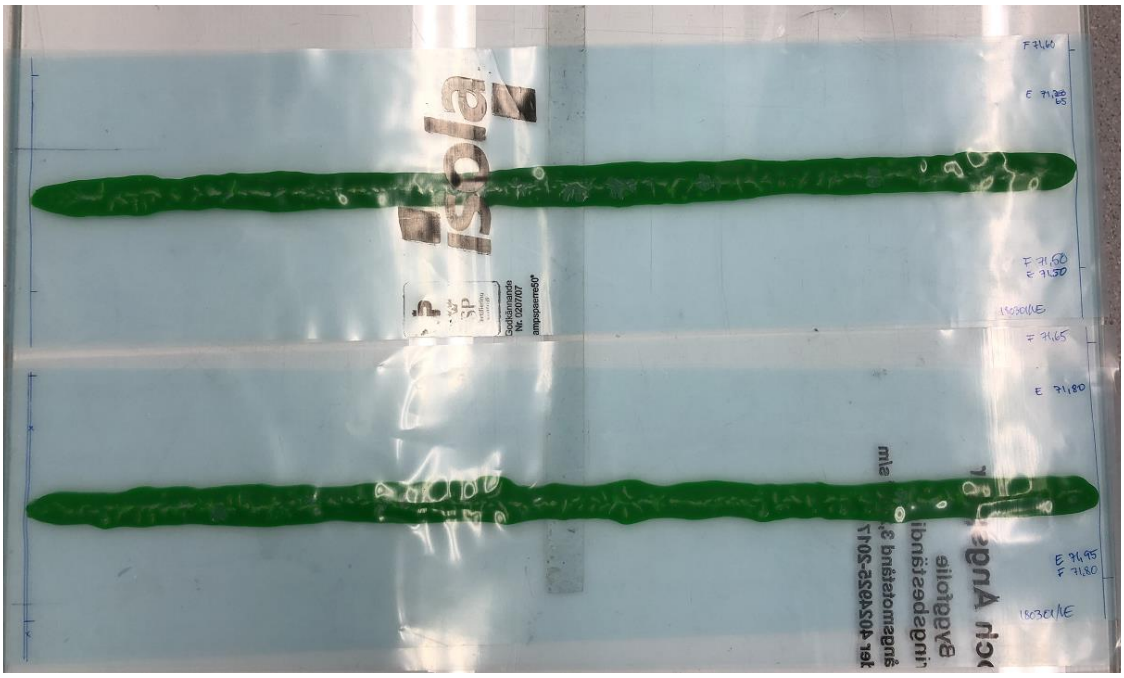

Figure 1.

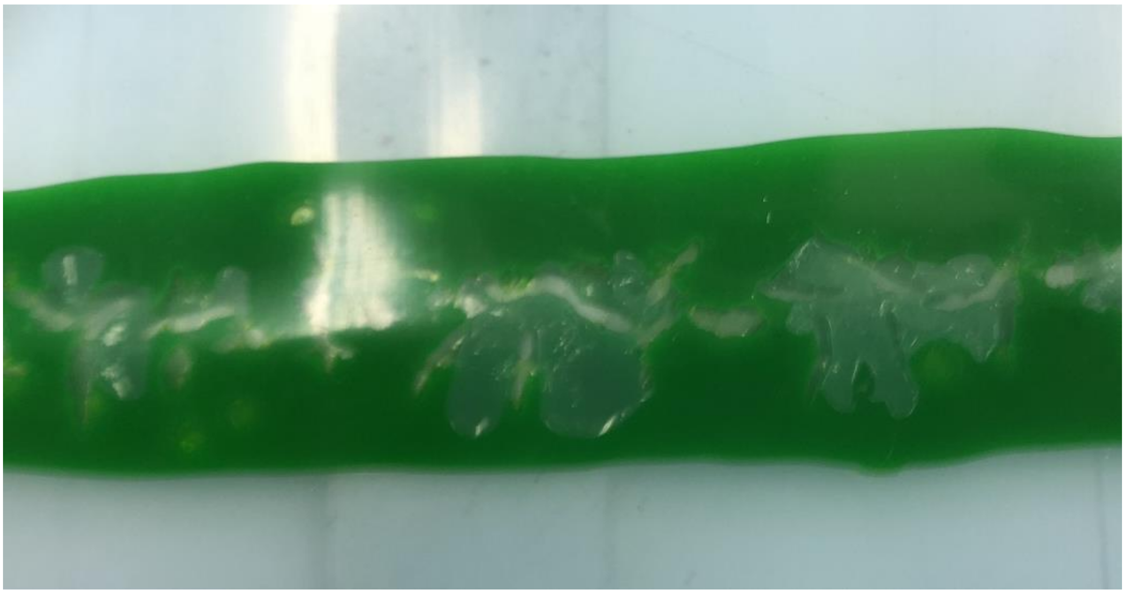

Figure 1.

Testing according to SP-method 1380 version 3.

Curing and ageing behaviour

Sample preparation with the joint sealant of the first batch that arrived at RISE was performed on 2017-04-10, on 2017-04-20 the samples looked as in Figure 3 below.

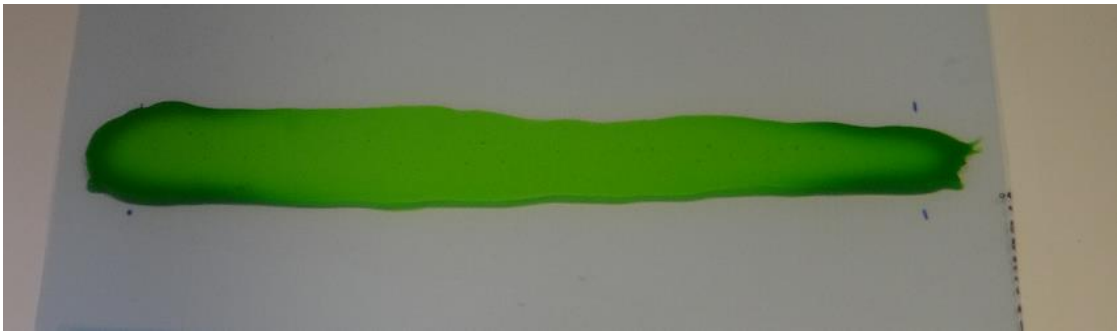

Figure 2. Sample on 2017-04-20.

The dark green colour in the edges of the joint sealant indicates that the curing has started there, but there is a lot of material not showing any signs of curing after 10 days.

After four weeks of curing the ageing exposure was started but it had to be stopped before fulltime as uncured material was leaking from the joint and that many bubbles and cracks appeared in the joint. See Figure 4 below. A shear test with a non-aged joint sample was also made, see results in Table 2.

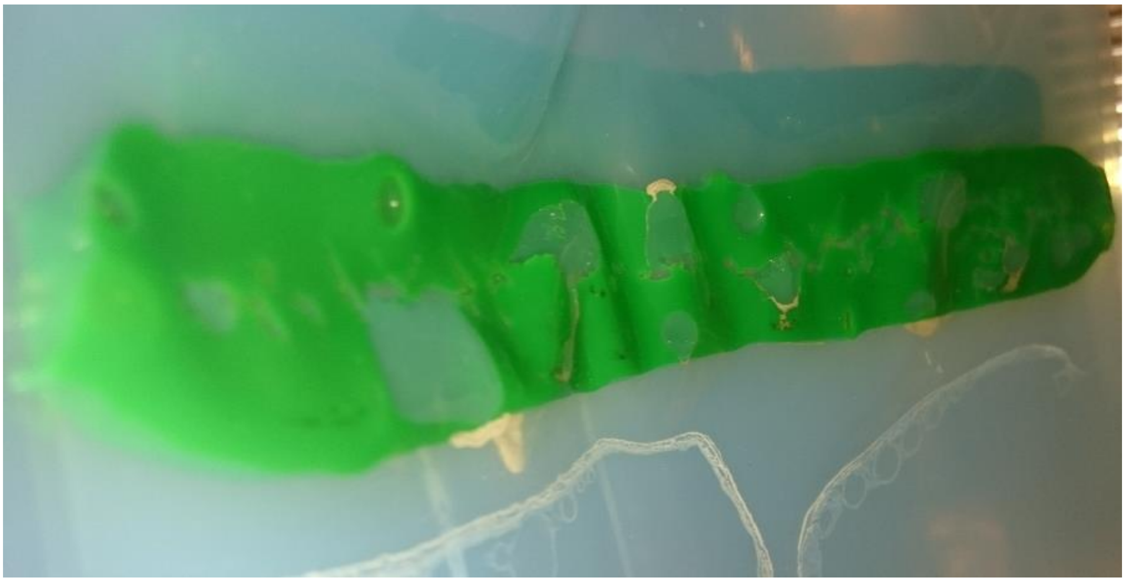

Figure 3. Joint that has been aged.

New tubes with joint sealant, batch number 219346, was sent to RISE for a new test. They were used for sample preparation on 2017-10-06. After that, the samples were left to cure in 23 °C/50 %RH until 2018-01-17, according to the customers recommendation, where after the ageing test was started. The curing time before the ageing test was started was thus 103 days. During the ageing test the samples were visually checked to see that they did not break as the samples did during the first ageing test. On 2018-02-12 the samples looked as in Figure 5 below.

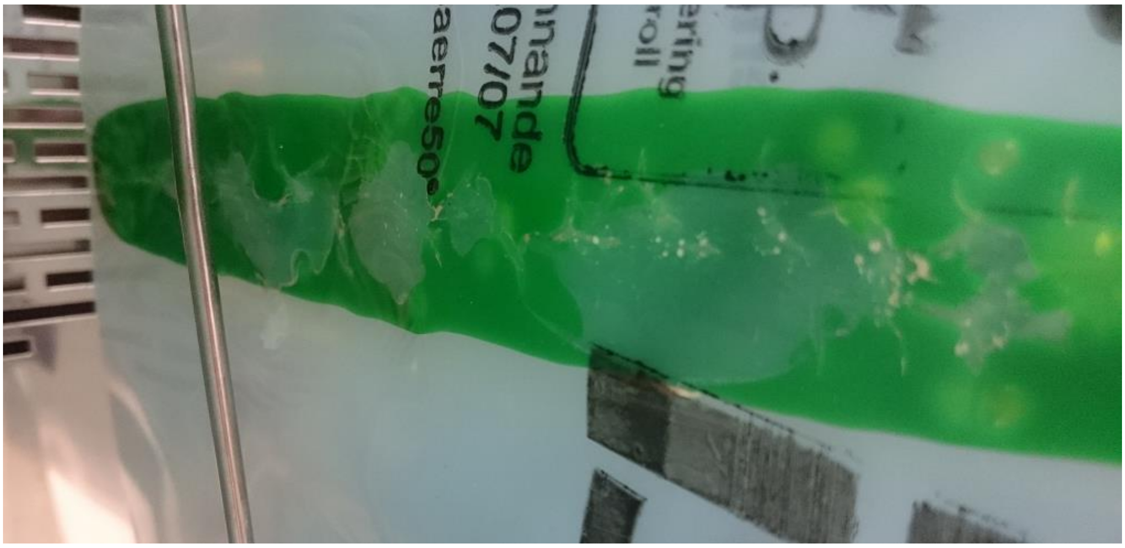

Figure 4.

Even during this ageing test bubbles between the joint sealant and the air and vapour barrier and several cracks in the joint sealant appeared, which indicates that the sealant probably was not completely cured when the ageing test was started even though it had been cured for a long time. It was however decided that the ageing test could continue. The samples were checked several times during the ageing test, but they still looked approximately as in Figure 5 above, so the ageing test was not stopped in advance this time.

Material composition
Collected spectrums can be found in Attachment 1 (1 page).

Shear test before and after ageing
Requirement; The shear strength before and after ageing must not be lower than 500 N/m.

Results; For results, see Table 2. Adhesion break means that the breakage occurs since the adhesive loses its grip to the air and vapour barrier, cohesion break means that the breakage is within the adhesive.

Table 2. Results from shear test.

	Sample	Max shear force	Break type
		N/m	
Unaged sample, approx. 1 month of curing, (first delivery of joint sealant samples).	**1**	147	Not fully cured
	2	150	Not fully cured
	3	121	Not fully cured
	4	168	Not fully cured
	5	177	Not fully cured
	Average	**152**	
	Std.dev.	**22**	
Unaged sample, tested at 2018-07-11 (278 days after sample preparation) (second delivery of joint sealant samples)	**1**	1033	Adhesion break 100%
	2	1033	Adhesion break 100%
	3	952	Cohesion break 100%
	4	861	Adhesion break 100%
	5	825	Cohesion break 100%
	Average	**941**	
	Std.dev.	**96**	
Aged samples (second delivery of joint sealant samples)	**1**	1831	Adhesion break 100%
	2	1695	Adhesion break 100%
	3	1602	Adhesion break 100%
	4	1871	Adhesion break 100%
	5	1670	Adhesion break 100%
	Average	**1734**	
	Std.dev.	**113**	

Tensile strain at break before and after ageing
Requirement; The tensile strain at break of aged material must not be lower than half the result of unaged material.

Results; For results, see Table 3.

Table 3. Results from testing of tensile strain at break.

Sample	Number	Strain
		%
Unaged sample	**1**	643
	2	643
	3	603
	4	636
	5	650
	Average	**635**
	Std.dev.	**19**
Sample aged full time	**1**	502
	2	462
	3	502
	4	552
	5	469
	Average	**497**
	Std.dev.	**36**
	Change	**-22%**

Water vapour transmission resistance before and after ageing
Requirement; The water vapour transmission resistance of the splice before and after ageing must not be lower than $1.5 \cdot 10^6$ s/m.

Results; For results, see Table 4 and 5. The results are presented according to SP CR 128 Attachment 1 as the water vapour transmission resistance of the splice, instead of g- and µ-values.

Table 4. Results of testing of the water vapour transmission resistance of the splice, unaged material.

Sample	Width of splice approx. [mm]	Water vapour transmission resistance Z_p [Pa·m²·s/kg]	Water vapour transmission resistance Z_v [s/m]	Equivalent air column at 1013.25 hPa s_d [m]
1	22	$5.2 \cdot 10^{11}$	$3.8 \cdot 10^{6}$	102
2	26	$5.3 \cdot 10^{11}$	$3.9 \cdot 10^{6}$	103
3	25	$5.1 \cdot 10^{11}$	$3.7 \cdot 10^{6}$	99
4*	27	$4.6 \cdot 10^{11}$	$3.4 \cdot 10^{6}$	91
Average	**-**	**$5.2 \cdot 10^{11}$**	**$3.8 \cdot 10^{6}$**	**101**
Standard deviation	**-**	**1.1E•10^{10}**	**$7.7 \cdot 10^{4}$**	**2**

* Not included during calculation of the average value and the standard deviation due to a large variation of the results during the testing of this sample. Three values are however enough for the calculation of the result.

Table 5. Results of testing of the water vapour transmission resistance of the splice, aged material.

Sample	Width of splice approx. [mm]	Water vapour transmission resistance Z_p [Pa·m²·s/kg]	Water vapour transmission resistance Z_v [s/m]	Equivalent air column at 1013.25 hPa s_d [m]
1*	27	$1.2 \cdot 10^{11}$	$8.5 \cdot 10^{5}$	23
2	27	$3.8 \cdot 10^{11}$	$2.7 \cdot 10^{6}$	73
3	24	$3.9 \cdot 10^{11}$	$2.8 \cdot 10^{6}$	76
4	25	$4.1 \cdot 10^{11}$	$3.0 \cdot 10^{6}$	80
Average	**-**	**$3.9 \cdot 10^{11}$**	**$2.9 \cdot 10^{6}$**	**76**
Standard deviation	**-**	**$1.7 \cdot 10^{10}$**	**$1.2 \cdot 10^{5}$**	**3**

* Not included during calculation of the average value and the standard deviation due to a probable leakage of the sample. The cause of the leakage is unknown, so it is not possible to specify if the leakage is caused by either the tightness of the aged joint sample or the quality of the sample cup prepared for this measurement. Three values are however enough for the calculation of the result.

As there was a rather large variation of the width of the joint sealant between the prepared samples a measured average width of the joint sealant in each sample has been included in Table 4 and 5 above. These values are not exact but have been estimated from several measurement points on each sample. For pictures of the samples see Figure 6 and 7 below.

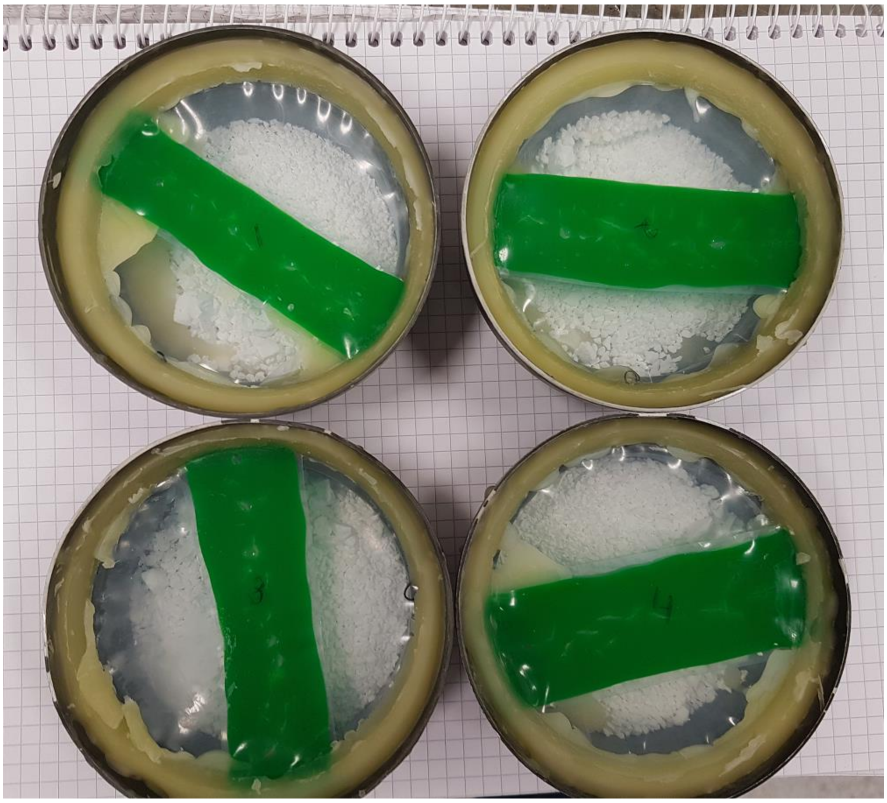

Figure 5. Samples for measurement of the water vapour transmission resistance, unaged samples.

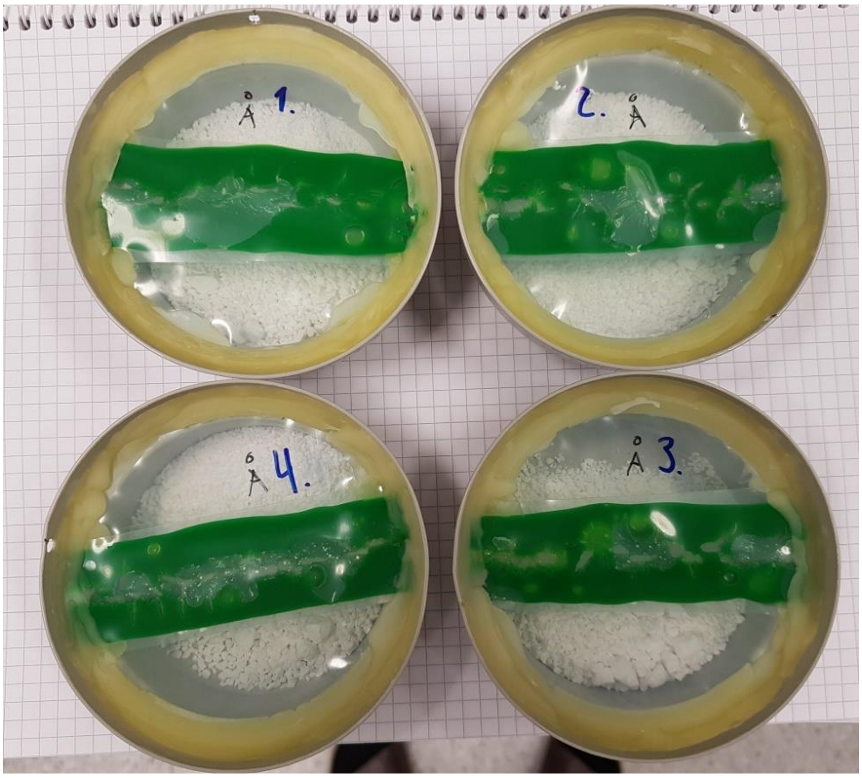

Figure 6. Samples for measurement of the water vapour transmission resistance, aged samples.

Conclusion and discussion

Specialfog Byggplast from ESSVE has been tested as a jointing material for air and vapour barriers used inside walls. The methods that has been used are SP-method 1380 version 3 and a modified version of SP-method 5138 (dimensional stability).The product has been evaluated against the requirements specified by the methods for the application as a jointing material between air and vapour barrier layers. At the first test conducted after sample preparation and curing of the joint for one month the material did not fulfil the requirements of the shear test. A retest was made, where among other tests a new shear test was performed after 278 days of curing. During the retest, results were obtained above the requirement levels, see Table 1 to 5 for results and requirements, but the very long curing time means that the product cannot be considered suitable as a jointing material between two vapour-tight films. Other applications have not been assessed.

It can be so that an application with vapour-tight film on one side only can facilitate the curing of the tested product. Furthermore, discharge of water is said to be important for the curing, and then it is possible to speculate that the two air and vapour barriers have prolonged the curing time. After one month of curing the shear test result was below the requirement level, and new samples were due to that cured for more than 100 days, as agreed with the client, before the ageing test was started so that uncured material would not damage the samples. As the curing time is very long, it is difficult to say how the function of this product is after it has been applied since it is difficult to say how the joint behaves when it is exposed to movements of the vapour barrier during the usage phase caused by e.g. pressure loads and movements in the construction plus that it is hard to ensure that the curing works satisfactorily in a dense construction.

The results presented in this report is only related to the tested samples.

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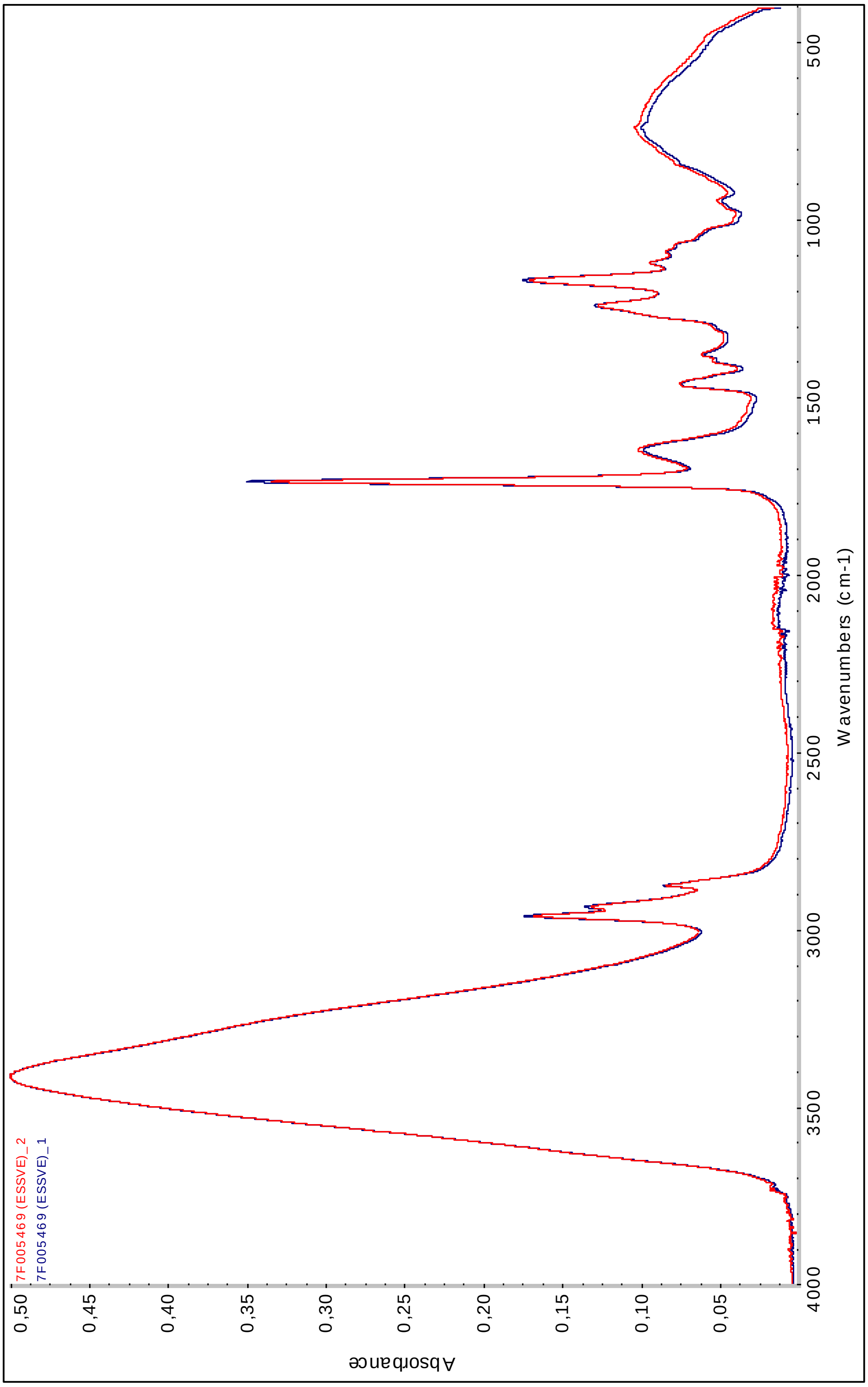
Appendices

1. FTIR-spectrums
2. Measurement uncertainty

Appendix 1

FTIR-spectrum; Specialfog byggplast



Appendix 2

Uncertainty of measurement

SP-method 1380: Tensile strain at break	± 2.1 %	1) 2)
SP-method 1380: Shear test	± 3.5 %	1)
EN 1931: Water vapour transmission resistance	± 10 %	1)

The reported uncertainty is an expanded uncertainty (U), based on a standard uncertainty multiplied by a coverage factor, k=2, which provides a level of confidence of approximately 95 %.

[1]The uncertainty of measurement applies for a single measurement value. The spread in results due to variations in sample characteristics is not accounted for in the given uncertainty of measurement.

[2]Uncertainty in percent of measurement value.