

TEST REPORT N°2013B VEC 18373-2

Including 13 pages + 1 annex
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Mons, June 13th, 2013

REQUESTED BY : **AGC Glass Europe - R&D Centre**
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REFERENCE OF THE REQUEST : Order 450434334

CONCERNED MANUFACTURER : **AGC GLASS EUROPE**
Chaussée de la Hulpe, 166
1170 BRUXELLES
BELGIUM


NUMBER OF SAMPLES AND IDENTIFICATION : **SMART 51- Sikasil SG-500**

PURPOSE OF THE REQUESTED : Tests according to EOTA – ETAG 002
Mechanical Performances *

SAMPLES RECEIVED ON : 18/04/2013

TESTING DATE : From 22/04/2013

REMARKS : * Test under BELAC accreditation

 Notified body (Id.N°1174)
**according to ART.18 of the « Construction Products Directive » CPD
89/106/EEC**

TECHNICAL REPORT
ADHESION PERFORMANCES ACCORDING TO ETAG 002
GUIDELINE

SAMPLES

Samples were prepared by Sika AG on 25/02/2013 (see annex 1)

SMART 51 T – Sikasil SG-500 – SMART 51 NT

Batch : A : MI07410126 / B : MI00608121
Number of samples prepared : 90

RESULTS

The tests were conducted in compliance with the methods described in the "Guideline for European Technical Approval for Structural Sealant Glazing System (SSGS)" ETAG n° 002.

Définitions :

K_x = Stiffness of the sample at x% elongation in the initial state

$K_{x,c}$ = Stiffness of the sample at x% elongation after conditioning
 $= 100 \cdot \sigma_x / x$

$R_{u,5}$ = the characteristic breaking stress giving 75% confidence that 95% of the test result will be higher than this value
 $= X_{mean} - \tau_{\alpha\beta} \cdot S$

S = standard deviation of the serie under consideration

$X_{mean,n}$ = the average breaking stress, either under tension or shear in the initial state

$X_{mean,c}$ = the average breaking stress, either under tension or shear after conditioning

$\Delta X_{mean} = X_{mean,c} / X_{mean,n}$

Mechanical performances

5.1.4.1. INITIAL TESTS – INITIAL MECHANICAL STRENGTH

5.1.4.1.1. TENSION – RUPTURE*

a) Results for 10 samples conditioned at +23°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	620	0.14	0.28	0.38	0.45	0.52	1.03	88	100C
2	637	0.16	0.29	0.38	0.46	0.52	0.97	78	100C
3	656	0.19	0.31	0.41	0.48	0.55	0.94	66	100C
4	638	0.14	0.27	0.36	0.44	0.51	0.83	59	100C
5	666	0.13	0.28	0.37	0.45	0.52	0.91	68	100C
6	630	0.16	0.29	0.38	0.45	0.52	0.94	72	100C
7	657	0.19	0.32	0.41	0.49	0.56	0.96	69	100C
8	627	0.16	0.29	0.39	0.47	0.54	1.00	75	100C
9	624	0.17	0.29	0.39	0.46	0.53	0.95	70	100C
10	670	0.17	0.31	0.40	0.48	0.55	0.91	61	100C
Average	642	0.16	0.29	0.39	0.46	0.53	0.94	71	
Standard deviation	18	0.02	0.02	0.02	0.02	0.02	0.05	8	
Minimum	620	0.13	0.27	0.36	0.44	0.51	0.83	59	
Maximum	670	0.19	0.32	0.41	0.49	0.56	1.03	88	

(*) xC: x% cohesive / xA: x% adhesive

Ru,5 = 0.84

b) Results for 5 samples conditioned at -20°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	685	0.15	0.30	0.39	0.47	0.53	1.12	102	100C
2	619	0.13	0.29	0.38	0.46	0.53	1.12	98	100C
3	645	0.12	0.30	0.40	0.48	0.55	1.08	82	100C
4	690	0.16	0.32	0.42	0.50	0.56	1.10	86	100C
5	645	0.15	0.31	0.41	0.48	0.55	1.08	88	100C
Average	657	0.14	0.30	0.40	0.48	0.54	1.10	91	
Standard deviation	30	0.02	0.01	0.02	0.01	0.01	0.02	8	
Minimum	619	0.12	0.29	0.38	0.46	0.53	1.08	82	
Maximum	690	0.16	0.32	0.42	0.50	0.56	1.12	102	

(*) xC: x% cohesive / xA : x% adhesive

$$Ru,5 = 1.05$$

$$\Delta X_{\text{mean}} = 1.17$$

c) Results for 5 samples conditioned at +80°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	672	0.15	0.30	0.41	0.50	0.58	0.90	50	100C
2	633	0.16	0.31	0.41	0.50	0.58	1.07	66	100C
3	650	0.16	0.30	0.40	0.49	0.56	0.93	55	100C
4	645	0.15	0.29	0.40	0.49	0.57	0.95	56	100C
5	642	0.19	0.39	0.58	0.73	0.85	0.86	25	100C
Average	649	0.16	0.32	0.44	0.54	0.63	0.94	51	
Standard deviation	15	0.02	0.04	0.08	0.11	0.12	0.08	15	
Minimum	633	0.15	0.29	0.40	0.49	0.56	0.86	25	
Maximum	672	0.19	0.39	0.58	0.73	0.85	1.07	66	

(*) xC: x% cohesive / xA: x% adhesive

$$Ru,5 = 0.74$$

$$\Delta X_{\text{mean}} = 1.00$$

5.1.4.1.2. SHEAR – RUPTURE*

a) Results for 10 samples conditioned at +23°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	broken								
2	623	0.03	0.07	0.10	0.13	0.16	0.58	138	100C
3	650	0.03	0.07	0.10	0.13	0.16	0.66	133	100C
4	612	0.06	0.10	0.13	0.15	0.18	0.64	132	100C
5	629	0.05	0.09	0.12	0.15	0.17	0.64	131	100C
6	696	0.04	0.09	0.12	0.15	0.17	0.65	132	100C
7	625	0.04	0.07	0.10	0.13	0.16	0.65	140	100C
8	641	0.05	0.09	0.12	0.15	0.17	0.63	130	100C
9	663	0.05	0.09	0.13	0.15	0.18	0.67	127	100C
10	619	0.05	0.08	0.11	0.14	0.17	0.66	140	100C
Average	640	0.04	0.08	0.11	0.14	0.17	0.64	134	
Standard deviation	27	0.01	0.01	0.01	0.01	0.01	0.03	5	
Minimum	612	0.03	0.07	0.10	0.13	0.16	0.58	127	
Maximum	696	0.06	0.10	0.13	0.15	0.18	0.67	140	

(*) xC: x% cohesive / xA: x% adhesive

Ru,5 = 0.58

b) Results for 5 samples conditioned at -20°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10% stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	612	0.06	0.10	0.13	0.16	0.18	0.70	137	100C
2	631	0.04	0.08	0.11	0.14	0.17	0.83	170	100C
3	657	0.05	0.08	0.12	0.15	0.17	0.72	159	100C
4	648	0.05	0.09	0.13	0.15	0.18	0.80	152	100C
5	614	0.03	0.08	0.11	0.14	0.17	0.82	167	100C
Average	632	0.05	0.09	0.12	0.15	0.17	0.77	157	
Standard deviation	20	0.01	0.01	0.01	0.01	0.01	0.06	13	
Minimum	612	0.03	0.08	0.11	0.14	0.17	0.70	137	
Maximum	657	0.06	0.10	0.13	0.16	0.18	0.83	170	

(*) xC: x% cohesive / xA: x% adhesive

$$R_{u,5} = 0.62$$

$$\Delta X_{\text{mean}} = 1.20$$

c) Results for 5 samples conditioned at +80°C

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10% stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	656	0.02	0.03	0.04	0.05	0.08	0.67	134	100C
2	632	0.05	0.10	0.14	0.17	0.20	0.61	109	100C
3	652	0.04	0.08	0.12	0.15	0.18	0.81	132	100C
4	627	0.04	0.09	0.13	0.16	0.19	0.62	116	100C
5	636	0.03	0.07	0.10	0.13	0.16	0.53	95	100C
Average	640	0.04	0.07	0.11	0.13	0.16	0.65	117	
Standard deviation	13	0.01	0.03	0.04	0.05	0.05	0.10	16	
Minimum	627	0.02	0.03	0.04	0.05	0.08	0.53	95	
Maximum	656	0.05	0.10	0.14	0.17	0.20	0.81	134	

(*) xC: x% cohesive / xA: x% adhesive

$$R_{u,5} = 0.40$$

$$\Delta X_{\text{mean}} = 1.02$$

5.1.4.2. RESIDUAL MECHANICAL STRENGTH AFTER ARTIFICIAL AGEING

5.1.4.2.1 IMMERSION IN WATER AT HIGH TEMPERATURE WITH SOLAR RADIATION*

a) *Conditioning :*

- Duration : 2 x 21 days
- Water temperature : 44.9°C ± 0.3°C
- Conductivity of the water : 3.6 µs

b) *Results of the traction test after the artificial ageing :*

SMART 51 T

After 21 days :

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	657	0.07	0.15	0.21	0.27	0.32	0.92	109	100C
2	640	0.07	0.21	0.30	0.36	0.42	0.83	84	100C
3	663	0.12	0.24	0.32	0.38	0.44	0.91	110	100C
4	655	0.11	0.22	0.30	0.36	0.42	0.77	76	100C
5	621	0.09	0.21	0.30	0.37	0.43	0.80	77	100C
Average	647	0.09	0.21	0.29	0.35	0.41	0.85	91	
Standard deviation	17	0.02	0.03	0.04	0.04	0.05	0.07	17	
Minimum	621	0.07	0.15	0.21	0.27	0.32	0.77	76	
Maximum	663	0.12	0.24	0.32	0.38	0.44	0.92	110	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 0.90$$

After 42 days :

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	668	0.14	0.25	0.33	0.40	0.46	0.85	77	100C
2	657	0.14	0.25	0.33	0.40	0.46	0.84	79	100C
3	635	0.15	0.26	0.34	0.41	0.47	0.86	82	100C
4	682	0.14	0.26	0.34	0.41	0.47	0.89	88	100C
5	652	0.14	0.25	0.33	0.39	0.45	0.86	89	100C
Average	659	0.14	0.25	0.33	0.40	0.46	0.86	83	
Standard deviation	17	0.00	0.01	0.01	0.01	0.01	0.02	6	
Minimum	635	0.14	0.25	0.33	0.39	0.45	0.84	77	
Maximum	682	0.15	0.26	0.34	0.41	0.47	0.89	89	

(*) xC: x% cohesive / xA: x% adhesive

$\Delta X_{\text{mean}} = 0.91$

SMART 51 NT

After 21 days :

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	657	0.07	0.15	0.21	0.27	0.32	0.92	109	100C
2	640	0.07	0.21	0.30	0.36	0.42	0.83	84	100C
3	663	0.12	0.24	0.32	0.38	0.44	0.91	110	100C
4	655	0.11	0.22	0.30	0.36	0.42	0.77	76	100C
5	621	0.09	0.21	0.30	0.37	0.43	0.80	77	100C
Average	647	0.09	0.21	0.29	0.35	0.41	0.85	91	
Standard deviation	17	0.02	0.03	0.04	0.04	0.05	0.07	17	
Minimum	621	0.07	0.15	0.21	0.27	0.32	0.77	76	
Maximum	663	0.12	0.24	0.32	0.38	0.44	0.92	110	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 0.90$$

After 42 days :

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	668	0.14	0.25	0.33	0.40	0.46	0.85	77	100C
2	657	0.14	0.25	0.33	0.40	0.46	0.84	79	100C
3	635	0.15	0.26	0.34	0.41	0.47	0.86	82	100C
4	682	0.14	0.26	0.34	0.41	0.47	0.89	88	100C
5	652	0.14	0.25	0.33	0.39	0.45	0.86	89	100C
Average	659	0.14	0.25	0.33	0.40	0.46	0.86	83	
Standard deviation	17	0.00	0.01	0.01	0.01	0.01	0.02	6	
Minimum	635	0.14	0.25	0.33	0.39	0.45	0.84	77	
Maximum	682	0.15	0.26	0.34	0.41	0.47	0.89	89	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 0.91$$

5.1.4.2.2 HUMIDITY AND NaCl ATMOSPHERE*

a) *Conditioning :*

- Duration : 480 hours
- NaCl concentration : 49 g/l
- pH : 6.7

b) *Results of the traction test after the artificial ageing :*

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	666	0.17	0.29	0.38	0.45	0.51	0.85	66	100C
2	636	0.16	0.28	0.37	0.44	0.50	0.94	86	100C
3	675	0.16	0.28	0.37	0.44	0.50	0.96	89	100C
4	662	0.17	0.29	0.37	0.44	0.50	0.99	99	100C
5	675	0.16	0.29	0.37	0.45	0.51	0.83	67	100C
6	603	0.14	0.26	0.35	0.41	0.47	0.96	97	100C
7	631	0.17	0.29	0.37	0.44	0.51	0.89	72	100C
8	635	0.17	0.28	0.36	0.43	0.49	0.84	71	100C
9	631	0.18	0.30	0.38	0.44	0.50	0.93	84	100C
10	648	0.17	0.29	0.38	0.45	0.51	0.86	68	100C
Average	646	0.17	0.29	0.37	0.44	0.50	0.91	80	
Standard deviation	23	0.01	0.01	0.01	0.01	0.01	0.06	13	
Minimum	603	0.14	0.26	0.35	0.41	0.47	0.83	66	
Maximum	675	0.18	0.30	0.38	0.45	0.51	0.99	99	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 0.97$$

5.1.4.2.3 HUMIDITY AND SO₂ ATMOSPHERE*

a) Conditioning :

- Duration : 20 cycles
- 0.2l SO₂

b) Results of the traction test after the artificial ageing

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	599	0.14	0.27	0.37	0.44	0.51	0.93	75	100C
2	632	0.16	0.28	0.37	0.44	0.51	0.91	73	100C
3	619	0.18	0.30	0.39	0.47	0.53	0.97	76	100C
4	621	0.16	0.28	0.37	0.44	0.51	0.96	80	100C
5	678	0.13	0.28	0.37	0.45	0.52	0.88	66	100C
6	651	0.15	0.28	0.37	0.45	0.52	0.91	71	100C
7	661	0.17	0.29	0.38	0.45	0.52	1.04	97	100C
8	656	0.16	0.29	0.38	0.45	0.52	0.86	63	100C
9	643	0.16	0.29	0.38	0.45	0.52	1.01	89	100C
10	628	0.17	0.29	0.38	0.45	0.52	1.01	92	100C
Average	639	0.16	0.29	0.38	0.45	0.52	0.95	78	
Standard deviation	24	0.01	0.01	0.01	0.01	0.01	0.06	11	
Minimum	599	0.13	0.27	0.37	0.44	0.51	0.86	63	
Maximum	678	0.18	0.30	0.39	0.47	0.53	1.04	97	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 1.01$$

5.1.4.2.4 Facade cleaning product*

a) *Conditioning :*

- Duration : 21 days
- Temperature : 43.5°C ± 0.5°C
- Cleaning product : Extran (5% on water)

b) *Results of the traction test after the artificial ageing :*

Sample number	Section (mm ²)	Limited to 5% stretch. (N/mm ²)	Limited to 10 % stretch. (N/mm ²)	Limited to 15% stretch. (N/mm ²)	Limited to 20% stretch. (N/mm ²)	Limited to 25% stretch. (N/mm ²)	Limit of breakage (N/mm ²)	Stretch on breaking (%)	Type of breakage (*)
1	623	0.15	0.26	0.33	0.39	0.45	0.87	92	100C
2	650	0.14	0.24	0.32	0.38	0.44	0.70	63	100C
3	638	0.16	0.27	0.35	0.41	0.47	0.92	96	100C
4	619	0.14	0.24	0.32	0.38	0.44	0.79	76	100C
5	619	0.12	0.25	0.33	0.39	0.45	0.88	86	100C
6	638	0.18	0.29	0.37	0.43	0.49	0.90	85	100C
7	661	0.16	0.27	0.35	0.42	0.48	0.90	89	100C
8	645	0.17	0.28	0.36	0.42	0.48	0.88	82	100C
9	637	0.16	0.27	0.34	0.41	0.47	0.92	103	100C
10	660	0.16	0.27	0.35	0.41	0.47	0.92	100	100C
Average	639	0.15	0.26	0.34	0.40	0.46	0.87	87	
Standard deviation	15	0.02	0.02	0.02	0.02	0.02	0.07	12	
Minimum	619	0.12	0.24	0.32	0.38	0.44	0.70	63	
Maximum	661	0.18	0.29	0.37	0.43	0.49	0.92	103	

(*) xC: x% cohesive / xA: x% adhesive

$$\Delta X_{\text{mean}} = 0.93$$

SUMMARY

ETAG GUIDELINE TEST NUMBER	TEST	TEST CONDITIO NS	CRITERIA				
			X _{mean} Mpa	ΔX_{mean} ≥ 0.75	K _{12.5} For $0 \leq x\% \leq 12.5$ $0.5 \leq K_{x,c}/K_x \leq 1.10$	R _{u,5}	TYPE OF BREAKAGE ($\geq 90\%$ C)
5.1.4.1.1	Tension	+23°C	0.94	-	$\sigma_{12.5}=0.32$ K _{12.5} = 2.57	0.84	100C
		-20°C	1.10	1.17		1.05	100C
		+80°C	0.94	1.00		0.74	100C
5.1.4.1.2	Shear	+23°C	0.64	-		0.58	100C
		-20°C	0.77	1.20		0.62	100C
		+80°C	0.65	1.02		0.40	100C
5.1.4.2.1	H ₂ O + UV SMART- 51 T face at 45°C	500 h	0.85	0.90			100C
		1000 h	0.86	0.91	$\sigma_{12.5,c}=0.28$ K _{12.5,c} = 2.24 K _{12.5,c} /K _{12.5} = 0.87		100C
5.1.4.2.1	H ₂ O + UV SMART- 51 NT face at 45°C	500 h	0.85	0.90			100C
		1000 h	0.86	0.91	$\sigma_{12.5,c}=0.28$ K _{12.5,c} = 2.24 K _{12.5,c} /K _{12.5} = 0.87		100C
5.1.4.2.2	H ₂ O + NaCl	480h	0.91	0.97			100C
5.1.4.2.3	H ₂ O + SO ₂	20 cycles	0.95	1.01			100C
5.1.4.2.4	Cleaning product	21 days	0.87	0.93			100C

(*) xC: x% cohesive

D. LIBERT
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Glazing and Components - INISMa