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TEST REPORT N°2012B VEC 16453-1

Including 13 pages + 1 annex
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Mons, November 30th, 2012

REQUESTED BY : **AGC Glass Europe - R&D Centre**
2 rue de l'Aurore
B-6040 Jumet
Belgium

REFERENCE OF THE REQUEST : PO 450365340

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


NUMBER OF SAMPLES AND IDENTIFICATION : **SMART-50 + DC3362**

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

SAMPLES RECEIVED ON : 14/08/2012

TESTING DATE : From 12/09/2012

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 Dow Corning Belgium on 06/07/2012 (see annex 1)

SMART-50 Tempered + DC-3362 + SMART-50

Batch A/B : N206061202/0006631486

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	605	0.12	0.27	0.37	0.45	0.52	0.89	59	100C
2	601	0.16	0.30	0.39	0.47	0.54	1.09	75	100C
3	594	0.13	0.28	0.37	0.45	0.52	0.90	62	100C
4	606	0.15	0.28	0.37	0.45	0.52	1.20	89	100C
5	596	0.12	0.27	0.37	0.46	0.53	1.10	77	100C
6	605	0.10	0.27	0.37	0.45	0.52	0.92	61	100C
7	598	0.16	0.31	0.40	0.49	0.56	0.94	59	100C
8	603	0.15	0.29	0.39	0.47	0.54	0.94	61	100C
9	594	0.14	0.28	0.38	0.47	0.54	1.26	91	100C
10	591	0.10	0.23	0.33	0.42	0.49	1.11	79	100C
Average	599	0.13	0.28	0.37	0.46	0.53	1.04	71	
Standard deviation	5	0.02	0.02	0.02	0.02	0.02	0.13	12	
Minimum	591	0.10	0.23	0.33	0.42	0.49	0.89	59	
Maximum	606	0.16	0.31	0.40	0.49	0.56	1.26	91	

(*) xC: x% cohesive

Ru,5 = 0.77

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	593	0.20	0.33	0.43	0.50	0.57	1.20	83	100C
2	610	0.22	0.34	0.42	0.49	0.56	1.24	90	100C
3	613	0.19	0.33	0.42	0.49	0.56	1.23	87	100C
4	595	0.15	0.28	0.39	0.47	0.54	1.13	78	100C
5	609	0.17	0.30	0.39	0.46	0.53	1.24	91	100C
Average	604	0.19	0.32	0.41	0.48	0.55	1.21	86	
Standard deviation	9	0.03	0.03	0.02	0.02	0.02	0.05	5	
Minimum	593	0.15	0.28	0.39	0.46	0.53	1.13	78	
Maximum	613	0.22	0.34	0.43	0.50	0.57	1.24	91	

(*) xC: x% cohesive

$$R_{u,5} = 1.09$$

$$\Delta X_{\text{mean}} = 1.16$$

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	581	0.12	0.26	0.37	0.45	0.53	0.84	48	100C
2	589	0.10	0.27	0.38	0.48	0.56	1.11	67	100C
3	603	0.14	0.30	0.41	0.49	0.57	0.82	45	100C
4	590	0.12	0.28	0.40	0.49	0.57	0.78	41	100C
5	593	0.16	0.32	0.43	0.52	0.60	0.79	41	100C
Average	591	0.13	0.29	0.40	0.49	0.57	0.87	48	
Standard deviation	8	0.02	0.02	0.02	0.03	0.03	0.14	11	
Minimum	581	0.10	0.26	0.37	0.45	0.53	0.78	41	
Maximum	603	0.16	0.32	0.43	0.52	0.60	1.11	67	

(*) xC: x% cohesive

$$R_{u,5} = 0.53$$

$$\Delta X_{\text{mean}} = 0.84$$

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	601	0.03	0.07	0.10	0.13	0.15	0.86	150	100C
2	594	0.03	0.07	0.11	0.13	0.16	0.68	128	100C
3	597	0.03	0.08	0.11	0.14	0.17	0.76	143	100C
4	613	0.03	0.07	0.10	0.13	0.16	0.69	129	100C
5	591	0.02	0.05	0.09	0.13	0.15	0.74	139	100C
6	619	0.02	0.06	0.10	0.13	0.15	0.80	176	100C
7	612	0.02	0.08	0.11	0.14	0.16	0.69	135	100C
8	596	0.03	0.08	0.12	0.15	0.17	0.67	134	100C
9	605	0.03	0.08	0.11	0.14	0.16	0.64	119	100C
10	600	0.03	0.06	0.10	0.13	0.16	0.83	151	100C
Average	603	0.03	0.07	0.11	0.14	0.16	0.74	140	
Standard deviation	9	0.00	0.01	0.01	0.01	0.01	0.07	16	
Minimum	591	0.02	0.05	0.09	0.13	0.15	0.64	119	
Maximum	619	0.03	0.08	0.12	0.15	0.17	0.86	176	

(*) xC: x% cohesive

Ru,5 = 0.59

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	587	0.03	0.07	0.11	0.14	0.17	0.81	143	100C
2	605	0.02	0.06	0.09	0.13	0.15	0.89	161	100C
3	609	0.02	0.07	0.11	0.14	0.17	0.81	160	100C
4	592	0.02	0.08	0.12	0.15	0.17	0.96	174	100C
5	596	0.02	0.06	0.10	0.13	0.16	1.01	187	100C
Average	598	0.02	0.07	0.11	0.14	0.16	0.90	165	
Standard deviation	9	0.00	0.01	0.01	0.01	0.01	0.09	17	
Minimum	587	0.02	0.06	0.09	0.13	0.15	0.81	143	
Maximum	609	0.03	0.08	0.12	0.15	0.17	1.01	187	

(*) xC: x% cohesive

$$Ru,5 = 0.68$$

$$\Delta X_{\text{mean}} = 1.22$$

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	593	0.02	0.03	0.05	0.07	0.09	0.64	120	100C
2	588	0.01	0.04	0.07	0.10	0.12	0.51	106	100C
3	600	0.02	0.06	0.10	0.13	0.16	0.53	119	100C
4	597	0.02	0.05	0.09	0.13	0.16	0.51	97	100C
5	593	0.01	0.03	0.06	0.10	0.13	0.80	139	100C
Average	594	0.02	0.04	0.07	0.11	0.13	0.60	116	
Standard deviation	5	0.01	0.01	0.02	0.03	0.03	0.13	16	
Minimum	588	0.01	0.03	0.05	0.07	0.09	0.51	97	
Maximum	600	0.02	0.06	0.10	0.13	0.16	0.80	139	

(*) xC: x% cohesive

$$Ru,5 = 0.28$$

$$\Delta X_{\text{mean}} = 0.60$$

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 : 45.0°C ± 0.5°C
- Conductivity of the water : 2.8 µs

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

SMART-50 T UV exposed

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	618	0.13	0.23	0.30	0.36	0.41	0.89	96	100C
2	594	0.13	0.22	0.28	0.32	0.37	0.65	79	30A T Face
3	587	0.13	0.23	0.30	0.35	0.40	0.93	98	100C
4	597	0.13	0.23	0.30	0.36	0.41	0.96	94	100C
5	592	0.14	0.24	0.32	0.38	0.43	1.04	100	100C
Average	597	0.13	0.23	0.30	0.35	0.40	0.89	93	
Standard deviation	12	0.00	0.01	0.01	0.02	0.02	0.15	8	
Minimum	587	0.13	0.22	0.28	0.32	0.37	0.65	79	
Maximum	618	0.14	0.24	0.32	0.38	0.43	1.04	100	

(*) xC: x% cohesive

$$\Delta X_{\text{mean}} = 0.86$$

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	588	0.15	0.23	0.29	0.34	0.39	1.02	135	100C
2	611	0.15	0.23	0.29	0.34	0.39	1.05	191	100C
3	600	0.13	0.22	0.29	0.34	0.39	0.97	128	100C
4	586	0.15	0.24	0.30	0.35	0.40	1.05	177	100C
5	593	0.14	0.23	0.30	0.35	0.40	0.99	122	100C
Average	595	0.14	0.23	0.29	0.34	0.39	1.02	150	
Standard deviation	10	0.01	0.01	0.01	0.01	0.01	0.04	32	
Minimum	586	0.13	0.22	0.29	0.34	0.39	0.97	122	
Maximum	611	0.15	0.24	0.30	0.35	0.40	1.05	191	

(*) xC: x% cohesive

$$\Delta X_{\text{mean}} = 0.86$$

SMART-50 UV exposed

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	601	0.13	0.23	0.29	0.35	0.40	0.93	99	20A T face
2	594	0.16	0.26	0.33	0.38	0.43	0.96	116	100C
3	590	0.12	0.24	0.31	0.37	0.43	1.11	110	100C
4	608	0.14	0.23	0.30	0.35	0.40	0.85	101	15A T face
5	600	0.11	0.23	0.30	0.36	0.41	0.93	107	100C
Average	598	0.13	0.24	0.31	0.36	0.41	0.96	107	
Standard deviation	7	0.02	0.01	0.02	0.01	0.02	0.10	7	
Minimum	590	0.11	0.23	0.29	0.35	0.40	0.85	99	
Maximum	608	0.16	0.26	0.33	0.38	0.43	1.11	116	

(*) xC: x% cohesive

$$\Delta X_{\text{mean}} = 0.92$$

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	613	0.12	0.22	0.28	0.34	0.38	0.93	191	100C
2	596	0.13	0.22	0.29	0.34	0.39	0.98	124	100C
3	594	0.12	0.22	0.28	0.34	0.38	0.99	123	100C
4	605	0.14	0.22	0.28	0.33	0.37	0.94	170	100C
5	590	0.13	0.22	0.28	0.34	0.39	1.02	180	100C
Average	600	0.13	0.22	0.28	0.34	0.38	0.97	158	
Standard deviation	9	0.01	0.00	0.00	0.00	0.01	0.04	32	
Minimum	590	0.12	0.22	0.28	0.33	0.37	0.93	123	
Maximum	613	0.14	0.22	0.29	0.34	0.39	1.02	191	

(*) xC: x% cohesive

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

5.1.4.2.2 HUMIDITY AND NaCl ATMOSPHERE*

a) *Conditioning :*

- Duration : 480 hours
- NaCl concentration : 48.9 g/l
- pH : 6.6

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	616	0.16	0.26	0.34	0.40	0.46	0.96	86	100C
2	592	0.17	0.28	0.36	0.42	0.48	1.00	114	100C
3	575	0.15	0.25	0.33	0.40	0.46	0.98	84	100C
4	599	0.17	0.27	0.34	0.41	0.46	0.88	78	100C
5	593	0.16	0.26	0.33	0.40	0.45	0.88	78	100C
6	596	0.16	0.27	0.34	0.41	0.47	1.02	91	100C
7	591	0.16	0.26	0.33	0.40	0.45	0.95	120	100C
8	587	0.18	0.29	0.36	0.43	0.48	0.91	74	100C
9	609	0.16	0.26	0.34	0.40	0.46	1.04	93	100C
10	585	0.18	0.28	0.36	0.42	0.48	0.97	81	100C
Average	594	0.17	0.27	0.34	0.41	0.47	0.96	90	
Standard deviation	12	0.01	0.01	0.01	0.01	0.01	0.06	15	
Minimum	575	0.15	0.25	0.33	0.40	0.45	0.88	74	
Maximum	616	0.18	0.29	0.36	0.43	0.48	1.04	120	

(*) xC: x% cohesive

$$\Delta X_{\text{mean}} = 0.92$$

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	596	0.15	0.27	0.36	0.44	0.50	0.91	66	100C
2	628	0.16	0.28	0.36	0.43	0.49	1.06	84	100C
3	586	0.17	0.29	0.38	0.45	0.51	1.06	82	100C
4	602	0.17	0.29	0.37	0.44	0.51	0.98	72	100C
5	604	0.15	0.27	0.35	0.42	0.48	1.13	94	100C
6	607	0.16	0.28	0.37	0.44	0.50	0.91	68	100C
7	615	0.17	0.29	0.37	0.44	0.50	1.06	83	100C
8	602	0.17	0.29	0.38	0.45	0.51	1.13	88	100C
9	609	0.15	0.27	0.35	0.42	0.48	1.03	82	100C
10	601	0.17	0.29	0.38	0.45	0.51	1.01	78	100C
Average	605	0.16	0.28	0.37	0.44	0.50	1.03	80	
Standard deviation	11	0.01	0.01	0.01	0.01	0.01	0.08	9	
Minimum	586	0.15	0.27	0.35	0.42	0.48	0.91	66	
Maximum	628	0.17	0.29	0.38	0.45	0.51	1.13	94	

(*) xC: x% cohesive

$$\Delta X_{\text{mean}} = 0.99$$

5.1.4.2.4 Facade cleaning product*

a) *Conditioning :*

- Duration : 21 days
- Temperature : 44.0°C ± 0.6°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	592	0.12	0.20	0.27	0.32	0.37	1.02	176	100C
2	597	0.12	0.20	0.26	0.31	0.36	0.99	208	100C
3	595	0.12	0.21	0.27	0.32	0.37	1.10	169	100C
4	594	0.13	0.22	0.28	0.34	0.38	1.17	191	100C
5	602	0.12	0.20	0.27	0.32	0.36	1.00	130	100C
6	601	0.14	0.22	0.28	0.33	0.38	1.08	226	100C
7	583	0.14	0.22	0.28	0.33	0.38	1.01	206	100C
8	599	0.13	0.21	0.27	0.32	0.37	1.06	180	100C
9	591	0.13	0.21	0.28	0.33	0.38	1.06	194	100C
10	622	0.12	0.21	0.27	0.32	0.37	0.94	120	100C
Average	598	0.13	0.21	0.27	0.32	0.37	1.04	180	
Standard deviation	10	0.01	0.01	0.01	0.01	0.01	0.07	33	
Minimum	583	0.12	0.20	0.26	0.31	0.36	0.94	120	
Maximum	622	0.14	0.22	0.28	0.34	0.38	1.17	226	

(*) xC: x% cohesive

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

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	1.04	-	$\sigma_{12.5}=0.31$ K _{12.5} = 2.45	0.77	100C
		-20°C	1.21	1.16		1.09	100C
		+80°C	0.87	0.84		0.53	100C
5.1.4.1.2	Shear	+23°C	0.74	-		0.59	100C
		-20°C	0.90	1.22		0.68	100C
		+80°C	0.60	0.81		0.28	100C
5.1.4.2.1	H ₂ O + UV SMART- 50 face at 45°C	500 h	0.96	0.92			93C
		1000 h	0.97	0.93	$\sigma_{12.5,c}=0.24$ K _{12.5,c} = 1.91 K _{12.5,c} /K _{12.5} = 0.78		100C
5.1.4.2.1	H ₂ O + UV SMART- 50 T face at 45°C	500 h	0.89	0.86			94C
		1000 h	1.02	0.98	$\sigma_{12.5,c}=0.25$ K _{12.5,c} = 2.00 K _{12.5,c} /K _{12.5} = 0.82		100C
5.1.4.2.2	H ₂ O + NaCl	480h	0.96	0.92			100C
5.1.4.2.3	H ₂ O + SO ₂	20 cycles	1.03	0.99			100C
5.1.4.2.4	Cleaning product	21 days	1.04	1.00			100C

*x*C = *x*% cohesive

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Glazing and Components - INISMa