REPORT

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Testing of anti-graffiti products according AMA Anläggning - OFF Lin

(2 appendices)

1 Commission

Testing of *OFF Lin* according to the instructions in *AMA Anläggning 20 Table LEB/1-2.*

2 Test program

Tested objects and number of test are given in Table 1. The tests have been carried out between February and June 2020.

Table.1 Test program

Property	**Method** AMA Anläggning 20, LEB/1 and 2	**Test specimens** bxhxl (mm)	Number
Influence on the frost resistance of the concrete	SS-EN 13 581:2002	100x100x100	4 treated 4 untreated
Influence on the drying of the concrete	SS-EN 13 579:2002	100x100x100	3 treated 3 untreated
Performance test	AMA Anläggning 20, Tabell LEB/2	100x50x500	3 treated

The concrete and the test specimens were prepared, cured and stored at RISE according to the instructions in SS-EN 1766:2017.

The anti-graffiti products were received at RISE 2020-02-21 and was applied by RISE according to the producers recommendations. The amount of product applied which is given in Appendix 1 was controlled by weighing. RISE has no other knowledge about the product or its sampling.

3 Test procedures and results

3.1 Influence on the frost resistance of the concrete

The influence on the frost resistance of the concrete has been verified according to SS-EN 13 581. The results are given as the mean value of results from four specimens. The weight change of the specimens due to scaling caused by frost action during the test is shown in Diagram 1. The test procedures for both treated and untreated specimens and measurement data are given in Appendix 1.

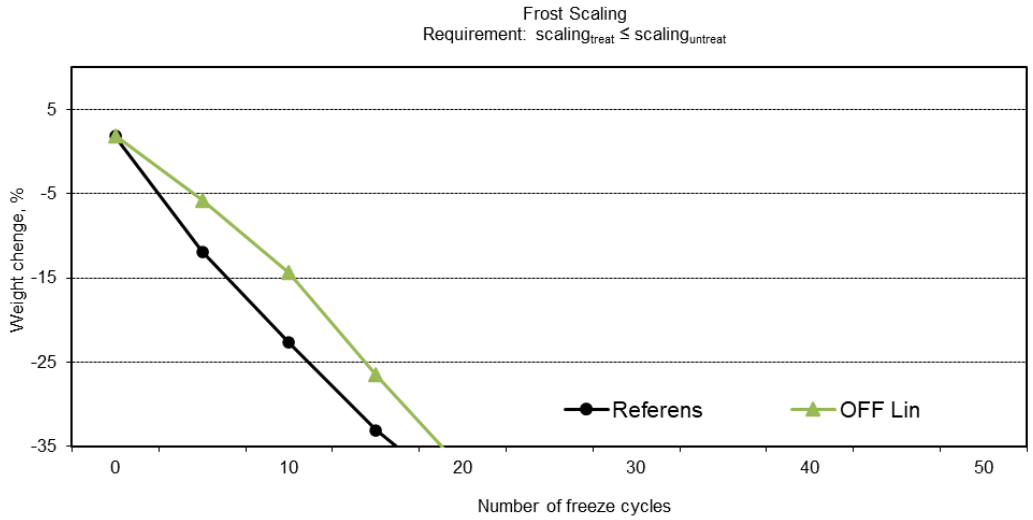

Diagram 1. Weight change

3.2 Influence on the drying of the concrete

The influence of the drying of the concrete has been verified according to SS-EN 13 579. The results are shown in Diagram 2. The results are given as mean values of results from three specimens. The test procedures for both treated and untreated specimens and measurement data are given in Appendix 1.

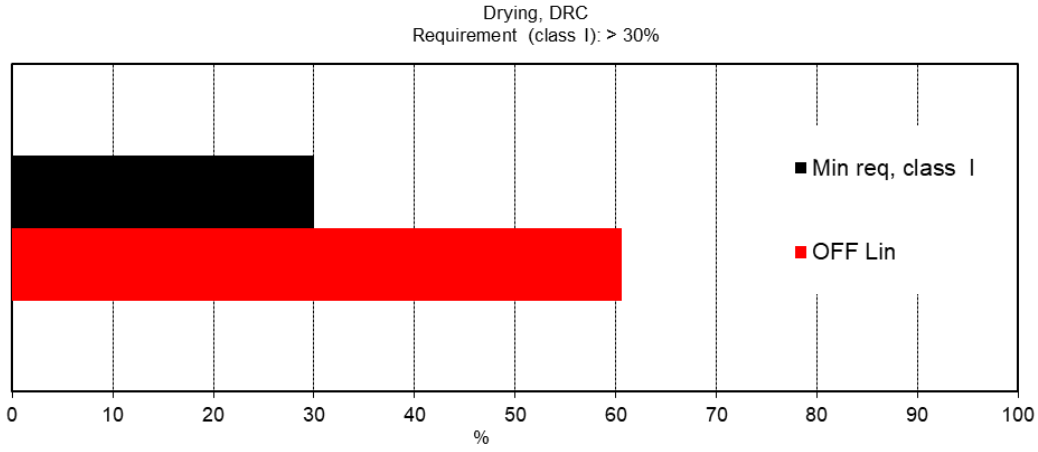

Diagram 2. Drying coefficient (DRC)

3.3 Anti-graffiti performance

After storage according to EN 1766 the three test specimens were conditioned for 7 days in 21±2C, 60±10 RH. Then the colour and the gloss of the test surfaces were measured. The anti-graffiti products were thereafter applied on the surface of the test specimens according to the producers instructions. The application was carried out on the upper side of the test specimens placed in horizontal position. The specimens were then stored for an additional 7 days in the same climate.

The test specimens were thereafter placed at the outdoors test location at RISE in Borås for 3 months, between January and Mars 2020, freely exposed towards south. During this exposure the specimens were mounted on a support giving a 45° inclination of the test surface in relation to a horizontal position. When the outdoors exposure was terminated, the specimens were stored for another 7 days in 21±2C, 60±10 RH and subsequently the colour and gloss was measured. The five specified colours were applied on each of the three specimens with the means of a template.

After 7 days the test specimens were cleaned. For the cleaning the test specimens were placed with the test surface in a vertical position in a suitable frame. The cleaning was carried out with the means of a high pressure washer providing a water amount of 20 litres/min, with a pump pressure of 120±10 bar, a water temperature of maximum 70°C and a spray angle about 25° during two minutes per test specimen. The distance between the nozzle and the test surface was around 0.1 m. After the cleaning of the graffiti the test specimens were stored in 21±2C, 60±10 RH for 7 days. Colour and gloss were then measured on the cleaned test specimens.

The results are shown in Diagram 3 for colour changes and in Diagram 4 for gloss changes. they are given as mean values of three results for colour and of ten results for gloss, respectively. Test procedures and measurement data are given in Appendix 1.

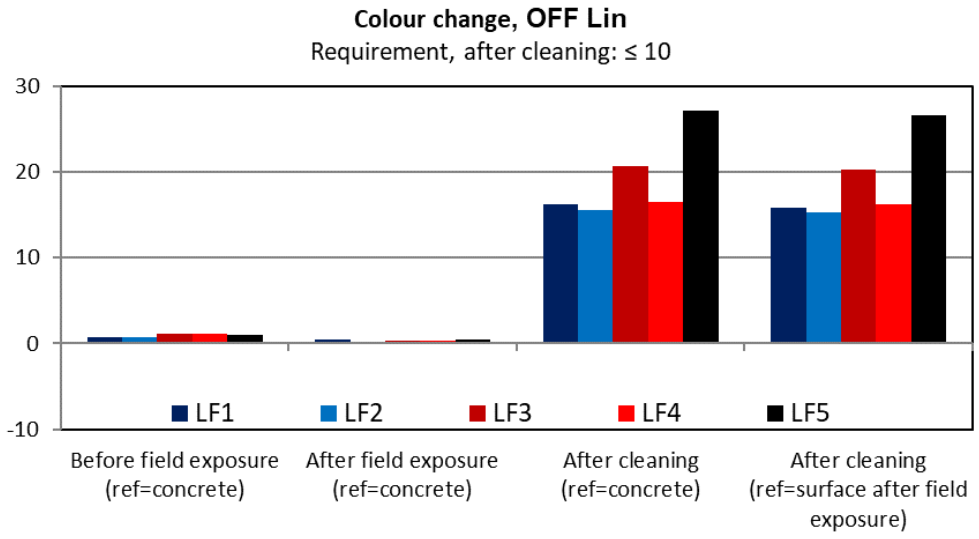

Diagram 3. Colour changes

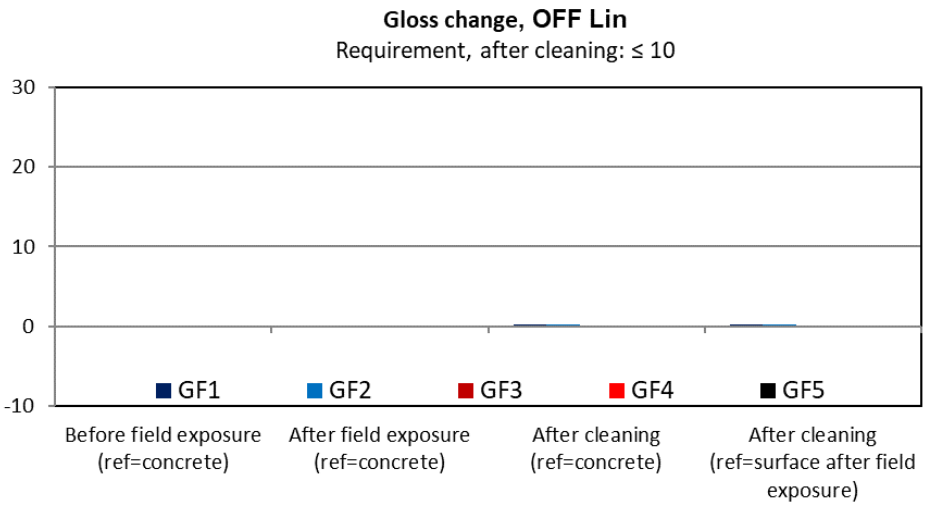

Diagram 4. Gloss changes

4 Evaluation and interpretation of results

Evaluation with regard to the influence on the frost resistance of concrete and Drying coefficient (DRC) show that OFF Lin fulfils the requirements.

For colour and gloss changes the following two evaluations have been carried out.

Evaluation I

Colour and gloss of the clean concrete surface, i.e. before the application of the anti-graffiti product have been compared to colour and gloss of the concrete surface after cleaning. This evaluation takes into account the colour of the anti-graffiti product, influence of weather during the exposure and the performance of the anti-graffiti product as protection against graffiti. The requirement on maximum 10 units as regards colour changes is not fulfilled.

Evaluation II

Colour and gloss of the surface with the anti-graffiti product after the outdoor exposure have been compared to colour and gloss of the concrete surface after cleaning. This evaluation takes into account the ability of the anti-graffiti product to protect against graffiti after field exposure. The requirement on maximum 10 units as regards colour changes is not fulfilled.

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Appendices

1 Test procedures, measurement data, evaluation of results

2 Photo documentation after cleaning

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

Appendix 1

Drying, SS-EN 13 579

	Datum		REF			OFF Lin		REF *i 105±5 C*	
Preparation/water curing	2019-10-07								
				g			g		g
Weighing/cond	2020-02-24	W_{ssd}	*R1*	2424,3		*LIN-1*	2431,8	*RT1*	2439,4
Placing i 21±2C, 60±10 RF	12:00		*R2*	2435,4		*LIN-2*	2440,3	*RT2*	2422,1
Placing i 105±5 C			*R3*	2452,6		*LIN-3*	2450,6	*RT3*	2452,9
				2437,4			2440,9		2438,1
Weighing	2020-03-02	W_{od}						*RT1*	2313,4
after drying i 105±5 C								*RT2*	2298,3
								RT3	2329,3
		M_{ssd}	*(%)*						5,4
Weighing	2020-02-27	W_3	*R1*	2413,4		*LIN-1*	2421,2		
21±2C, 60±10 RF			*R2*	2424,1		*LIN-2*	2428,9		
			R3	2441,7		*LIN-3*	2439,1		
				2426,4			2429,7		
Weighing	2020-02-28	W_3	*R1*	2412,4		*LIN-1*	2420,2		
21±2C, 60±10 RF			*R2*	2423,1		*LIN-2*	2427,8		
			R3	2440,7		*LIN-3*	2438,2		
				2425,4			2428,7		
Weighing	2020-03-02	W_7	*R1*	2410,6		*LIN-1*	2418,3		
21±2C, 60±10 RF			*R2*	2421,1		*LIN-2*	2425,8		
			R3	2438,7		*LIN-3*	2436,3		
				2423,5			2426,8		
Moisture content (5,0±0,5)		M	%	***4,7***			***4,9***		
Drying - untreated									
Weighing	2020-03-02	d_o	*R1*	2410,6					
placing i 30±2C, 40±5 RF	Kl: 07:45		*R2*	2421,1					
			R3	2438,7					
				2423,5					
Weighing	2020-03-02	d_1	*R1*	2408,5					
after 6±0,1 h	Kl: 13:45		*R2*	2418,8					
			R3	2436,8					
				2421,4					
Weighing	2020-03-03	d_2	*R1*	2406,0					
after 24±0,1 h	Kl: 07:45		*R2*	2416,2					
			R3	2434,3					
				2418,8					
Drying rate		D_u	*(g/m² h)*	***2,34***					
Application I							*12 g*		
ca 200 g/m2	2020-03-02	W_{t1}				*LIN-1*	2418,3		
	Kl: 08:00	W_{t2}					2430,8		
							12,5		
						LIN-2	2425,8		
							2438,2		
							12,4		
						LIN-3	2436,3		
							2449,0		
							12,7		
							9 g		
Application II	2020-03-02	W_{t1}				*LIN-1*	2420,3		
ca 150 g/m2	Kl: 11:30	W_{t2}					2429,3		
1 h after application I							**9,0**		
						LIN-2	2427,8		
							2436,9		
							9,1		
						LIN-3	2438,4		
							2447,6		
							9,2		
Drying - treated									
Weighing	2020-03-04	d_o				*LIN-1*	2418,4		
placing i 30±2C, 40±5 RF	Kl: 08:00					*LIN-2*	2425,7		
						LIN-3	2436,3		
							2426,8		
Weighing	2020-03-05	d_1				*LIN-1*	2414,3		
after 24±0,1h	Kl: 08:00					*LIN-2*	2421,4		
						LIN-3	2431,8		
							2422,5		
	$d_1 < W_7$						*-4,3*		
Weighing	2020-03-06					*LIN-1*	2412,4		
after 48±0,1h	Kl: 08:00					*LIN-2*	2419,4		
						LIN-3	2429,6		
						d_2	**2420,5**		
	$d_1 < W_7$						*-6,3*		
Drying rate		D_t	*(g/m² h)*				***1,42***		
(Class I: > 30 %)		*DRC*	%				**60,6**		

Appendix 1

Frost resistance EN 13581

			Referens		OFF Lin	
Preparation/water cuting	**Datum**					
		12	4		*4*	
Contitioning	2020-02-17					
21±2C, 60±10 RF						
						12 g
Application I	2020-04-29	C_n			*F70-LIN-1*	2378,4
21±2C, 60±10 RF						2390,6
ca 200 g/m2						***12,2***
					F70-LIN-2	2330,3
						2342,6
						12,3
					F70-LIN-2	2347,3
						2359,3
						12,0
					F70-LIN-2	2347,2
						2359,5
						12,3
						9 g
Application II	2020-04-29	C_n			*F70-LIN-1*	2383,7
21±2C, 60±10 RF						2393,4
ca 150 g/m2						***9,7***
1 h after application I					*F70-LIN-2*	2335,3
						2344,8
						9,5
					F70-LIN-2	2352,7
						2362,0
						9,3
					F70-LIN-2	2352,2
						2361,6
						9,4
Weighing, time:	2020-05-12	W_o	*F70-R1*	2343,2	*F70-LIN-1*	2377,9
placed in 3% NaCl	Kl 10:00		*F70-R2*	2337,5	*F70-LIN-2*	2329,9
			F70-R3	2338,1	*F70-LIN-3*	2346,8
			F70-R4	2347,0	*F70-LIN-4*	2346,7
				2341,4		***2350,3***
Weighing, time:	2020-05-13	W_e	*F70-R1*	2390,2	*F70-LIN-1*	2423,7
after 24 h	Kl 10:00		*F70-R2*	2379,8	*F70-LIN-2*	2376,7
Start frost			*F70-R3*	2381,4	*F70-LIN-3*	2392,2
			F70-R4	2387,8	*F70-LIN-4*	2394,3
				2384,8		***2396,7***
		C_{abs}		***1,8***		***1,9***
Weighing, 5 c	2020-05-18	W_5	*F70-R1*	2090,9	*F70-LIN-1*	2264,9
			F70-R2	2183,4	*F70-LIN-2*	2176,6
			F70-R3	1964,6	*F70-LIN-3*	2221,1
			F70-R4	2011,8	*F70-LIN-4*	2196,6
				2062,7		***2214,8***
		ΔW_5, %		***-11,9***		***-5,8***
Weighing, 10 c	2020-05-23	W_{10}	*F70-R1*	1852,7	*F70-LIN-1*	2045,6
			F70-R2	1877,9	*F70-LIN-2*	1976,3
			F70-R3	1810,0	*F70-LIN-3*	1996,2
			F70-R4	1701,3	*F70-LIN-4*	2030,6
				1810,5		***2012,2***
		ΔW_{10}, %		***-22,7***		***-14,4***
Weighing, 15 c	2020-05-28	W_{15}	*F70-R1*	1669,3	*F70-LIN-1*	1716,4
			F70-R2	1554,4	*F70-LIN-2*	1744,8
			F70-R3	1568,7	*F70-LIN-3*	1683,1
			F70-R4	1475,1	*F70-LIN-4*	1762,6
				1566,9		***1726,7***
		ΔW_{15}, %		***-33,1***		***-26,5***
Weighing, 20 c	2020-06-02	W_{20}	*F70-R1*	1436,8	*F70-LIN-1*	1470,0
			F70-R2	1385,2	*F70-LIN-2*	1439,3
			F70-R3	1326,0	*F70-LIN-3*	1417,7
			F70-R4	1330,8	*F70-LIN-4*	1524,3
				1369,7		***1462,8***
		ΔW_{20}, %		***-41,5***		***-37,8***

Appendix 1

Performance test, AMA Anläggning 20

	Date								
Preparation/water curing			***OFF Lin***						
			F3 st C (0,45), F100x500						
Conditioning	2020-02-17		*GF-LIN-1*						
21±2C, 60±10 RF			*GF-LIN-2*						
			GF-LIN-3						
Colour measurement,refernce				*1*	*2*	*3*	*4*	5	
Inv. nr 103455	2020-02-24			*74,19*	*78,07*	*77,99*	*77,84*	77,60	
3 measurements				*75,13*	*79,31*	*78,67*	*77,45*	77,34	
21±2C, 60±10 RF				*75,77*	*78,70*	*77,91*	*77,12*	77,24	
L-value*		L_{01}	*GF-LIN-1*	***75,0***	***78,7***	***78,2***	***77,5***	***77,4***	
				75,89	*76,76*	*76,38*	*76,44*	*76,59*	
				76,07	*75,59*	*76,27*	*75,62*	*74,90*	
				75,77	*75,77*	*76,43*	*75,84*	*76,43*	
		L_{02}	*GF-LIN-2*	***75,9***	***76,0***	***76,4***	***76,0***	***76,0***	
				70,62	*72,78*	*71,42*	*72,33*	*71,37*	
				70,44	*72,13*	*72,11*	*72,65*	*71,65*	
				70,38	*73,02*	*72,68*	*72,78*	*71,94*	
		L_{03}	*GF-LIN-3*	***70,5***	***72,6***	***72,1***	***72,6***	***71,7***	
		Mean						***75,1***	
Gloss measurement, reference				*1*	*2*	*3*	*4*	5	
Inv. nr 103445	2020-02-24	G_{01}	*GF-LIN-1*	*0,1*	*0,2*	*0,0*	*0,0*	*0,2*	
mean of 10 measurements, 85gr									
21±2C, 60±10 RF		G_{02}	*GF-LIN-2*	*0,3*	*0,1*	*0,1*	*0,1*	*0,1*	
		G_{03}	*GF-LIN-3*	*0,4*	*0,2*	*0,0*	*0,0*	*0,0*	
		Mean						***0,1***	
Application I						*10 g*			
21±2C, 60±10 RF	2020-02-24		*GF-LIN-1*			*10,0*			
ca 200 g/m2	12:00								
			GF-LIN-2			*10,0*			
			GF-LIN-3			*10,0*			
Application II						*7,5*			
21±2C, 60±10 RF	2020-02-24		*GF-LIN-1*			*7,5*			
ca 150 g/m2	14:15								
			GF-LIN-2			*7,5*			
			GF-LIN-3			*7,5*			
Colour measurement, before field exposure				*1*	*2*	*3*	*4*	5	
3 measurements	2020-03-02			*73,74*	*77,57*	*76,53*	*76,14*	76,54	
21±2C, 60±10 RF				*74,75*	*78,12*	*77,10*	*75,74*	76,50	
L-value*				*75,06*	*77,92*	*76,21*	*75,85*	75,74	
		L_{01}	*GF-LIN-1*	***74,5***	***77,9***	***76,6***	***75,9***	***76,3***	
				75,11	*76,40*	*75,65*	*75,49*	*75,50*	
				75,39	*74,94*	*74,85*	*74,96*	*73,89*	
				74,87	*75,36*	*75,64*	*74,79*	*75,28*	
		L_{02}	*GF-LIN-2*	***75,1***	***75,6***	***75,4***	***75,1***	***74,9***	
				69,82	*71,81*	*70,68*	*71,26*	*70,34*	
				69,79	*71,33*	*70,93*	*71,73*	*70,60*	
				69,60	*72,32*	*71,61*	*72,20*	*71,40*	
		L_{03}	*GF-LIN-3*	***69,7***	***71,8***	***71,1***	***71,7***	***70,8***	
		Mean						***74,2***	
Color change		$L_0 - L_{ci}$		*0,5*	*0,8*	*1,6*	*1,6*	*1,1*	
		$L_0 - L_{ci}$		*0,8*	*0,5*	*1,0*	*0,9*	*1,1*	
		$L_0 - L_{ci}$		*0,7*	*0,8*	*1,0*	*0,9*	*0,9*	
								0,9	
		L_F		L_{F1}	L_{F2}	L_{F3}	L_{F4}	L_{F5}	
				0,7	***0,7***	***1,2***	***1,1***	***1,0***	
Gloss measurement, before field exposure				*1*	*2*	*3*	*4*	5	
mean of 10 measurements	2020-03-02	G_{01}	*GF-LIN-1*	*0,2*	*0,3*	*0,2*	*0,0*	*0,4*	
21±2C, 60±10 RF									
		G_{02}	*GF-LIN-2*	*0,4*	*0,4*	*0,3*	*0,3*	*0,3*	
		G_{03}	*GF-LIN-3*	*0,9*	*0,3*	*0,0*	*0,0*	*0,0*	
		Mean						***0,3***	
Gloss change		$G_0 - G_{c1}$		*-0,1*	*-0,2*	*-0,2*	*0,0*	*-0,2*	
		$G_0 - G_{c2}$		*-0,1*	*-0,3*	*-0,2*	*-0,2*	*-0,2*	
		$G_0 - G_{c3}$		*-0,5*	*-0,1*	*0,0*	*0,0*	*0,0*	
		G_F		G_{F1}	G_{F2}	G_{F3}	G_{F4}	G_{F5}	
				-0,2	***-0,2***	***-0,1***	***-0,1***	***-0,1***	

Appendix 1

Field exposure								
towards south, inclination 45°	2020-03-02		GF-LIN-1					
			GF-LIN-2					
			GF-LIN-3					
Conditioning								
Rengörning	2020-06-01		GF-LIN-1					
21±2C, 60±10 RF			GF-LIN-2					
			GF-LIN-3					
Colour measurement, after field exposure				1	2	3	4	5
3 measurements	2020-06-08			*73,92*	*77,68*	*77,28*	*77,38*	*77,40*
21±2C, 60±10 RF				*74,57*	*78,52*	*78,10*	*76,98*	*77,15*
L-value*				*75,09*	*78,09*	*76,96*	*76,80*	*77,03*
		L_{01}	GF-LIN-1	**74,5**	**78,1**	**77,4**	**77,1**	**77,2**
				75,53	*76,79*	*76,41*	*76,67*	*75,92*
				75,64	*76,53*	*76,60*	*75,79*	*73,97*
				75,63	*75,88*	*76,59*	*75,87*	*75,83*
		L_{02}	GF-LIN-2	**75,6**	**76,4**	**76,5**	**76,1**	**75,2**
				69,78	*71,61*	*70,96*	*71,50*	*70,68*
				70,11	*72,03*	*71,49*	*71,63*	*70,96*
				69,92	*72,76*	*72,26*	*72,03*	*71,46*
		L_{03}	GF-LIN-3	**69,9**	**72,1**	**71,6**	**71,7**	**71,0**
		Mean						**74,7**
Colour change		$L_0 - L_{ci}$		*0,5*	*0,6*	*0,7*	*0,4*	*0,2*
		$L_0 - L_{ci}$		*0,3*	*-0,4*	*-0,2*	*-0,1*	*0,7*
		$L_0 - L_{ci}$		*0,5*	*0,5*	*0,5*	*0,9*	*0,6*
								0,4
		L_F		L_{F1}	L_{F2}	L_{F3}	L_{F4}	L_{F5}
				0,5	*0,2*	*0,4*	*0,4*	*0,5*
Gloss measurement, after field exposure				1	2	3	4	5
mean of 10 measurements	2020-06-08	G_{01}	GF-LIN-1	*0,1*	*0,2*	*0,0*	*0,0*	*0,3*
21±2C, 60±10 RF								
		G_{02}	GF-LIN-2	*0,3*	*0,2*	*0,2*	*0,0*	*0,1*
		G_{03}	GF-LIN-3	*0,4*	*0,3*	*0,0*	*0,0*	*0,0*
		Mean						***0,1***
Gloss change		$G_0 - G_{c1}$		*0,0*	*-0,1*	*0,0*	*0,0*	*-0,1*
		$G_0 - G_{c2}$		*0,0*	*-0,1*	*-0,1*	*0,1*	*0,0*
		$G_0 - G_{c3}$		*0,0*	*-0,1*	*0,0*	*0,0*	*0,0*
		G_F		G_{F1}	G_{F2}	G_{F3}	G_{F4}	G_{F5}
				0,0	*-0,1*	*0,0*	*0,0*	*0,0*

Appendix 1

Cycle I								
Application of colour				1	2	3	4	5
21±2C, 60±10 RF	2020-06-08		GF-LIN-1					
			GF-LIN-2					
			GF-LIN-3					
Cleaning by washing, 2 min								
pressure: 120±10 bar,	2020-06-15		GF-LIN-1					
water temperature: <70°C			GF-LIN-2					
spray angle about: 25°			GF-LIN-3					
amount of water: 20 l/min								
Conditioning								
21±2C, 60±10 RF	2020-06-15		GF-LIN-1					
			GF-LIN-2					
			GF-LIN-3					
Colour measurement, after cleaning				1	2	3	4	5
3 measurements	2020-06-22			*57,86*	*60,02*	*53,75*	*58,06*	*47,80*
21±2C, 60±10 RF				*57,48*	*59,15*	*53,63*	*57,78*	*47,44*
L-value*				*57,89*	*59,16*	*53,10*	*57,63*	*47,11*
		L_{c1}	GF-LIN-1	***57,7***	***59,4***	***53,5***	***57,8***	***47,5***
				56,39	*60,96*	*57,70*	*58,37*	*48,59*
				55,45	*59,40*	*56,60*	*58,40*	*48,23*
				56,77	*59,96*	*56,57*	*57,98*	*47,54*
		L_{c2}	GF-LIN-2	***56,2***	***60,1***	***57,0***	***58,3***	***48,1***
				58,78	*61,22*	*53,54*	*60,54*	*48,03*
				58,27	*61,13*	*54,39*	*60,74*	*47,62*
				59,09	*61,75*	*55,04*	*59,71*	*48,36*
		L_{c3}	GF-LIN-3	***58,7***	***61,4***	***54,3***	***60,3***	***48,0***
		Mean						**55,9**
Colour change		$L_0 - L_{ci}$		*17,3*	*19,3*	*24,7*	*19,6*	*29,9*
		$L_0 - L_{ci}$		*19,7*	*15,9*	*19,4*	*17,7*	*27,9*
		$L_0 - L_{ci}$		*11,8*	*11,3*	*17,7*	*12,3*	*23,7*
Evaluation I								*19,2*
(colour+influence of weather+performance)		L_F		L_{F1}	L_{F2}	L_{F3}	L_{F4}	L_{F5}
		Req: ≤10		***16,3***	***15,5***	***20,6***	***16,5***	***27,1***
Gloss measurement, after cleaning				1	2	3	4	5
mean of 10 measurements	2020-06-22	G_{c1}	GF-LIN-1	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
21±2C, 60±10 RF		G_{c2}	GF-LIN-2	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
		G_{c3}	GF-LIN-3	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
		Mean						***0,0***
Gloss change		$G_0 - G_{c1}$		*0,1*	*0,2*	*0,0*	*0,0*	*0,2*
		$G_0 - G_{c2}$		*0,3*	*0,1*	*0,1*	*0,1*	*0,1*
		$G_0 - G_{c3}$		*0,4*	*0,2*	*0,0*	*0,0*	*0,0*
		G_F		G_{F1}	G_{F2}	G_{F3}	G_{F4}	G_{F5}
		Req: ≤10		***0,3***	***0,2***	***0,0***	***0,0***	***0,1***
Evaluation II (performance)								
Colour change		$L_0 - L_{ci}$		*16,8*	*18,7*	*24,0*	*19,2*	*29,7*
		$L_0 - L_{ci}$		*19,4*	*16,3*	*19,6*	*17,9*	*27,1*
		$L_0 - L_{ci}$		*11,2*	*10,8*	*17,2*	*11,4*	*23,0*
								18,8
		L_F		L_{F1}	L_{F2}	L_{F3}	L_{F4}	L_{F5}
		Req: ≤10		***15,8***	***15,2***	***20,3***	***16,2***	***26,6***
Gloss change		$G_0 - G_{c1}$		*0,1*	*0,2*	*0,0*	*0,0*	*0,3*
		$G_0 - G_{c2}$		*0,3*	*0,2*	*0,2*	*0,0*	*0,1*
		$G_0 - G_{c3}$		*0,4*	*0,3*	*0,0*	*0,0*	*0,0*
		G_F		G_{F1}	G_{F2}	G_{F3}	G_{F4}	G_{F5}
		Req: ≤10		***0,3***	***0,2***	***0,1***	***0,0***	***0,1***

Appendix 2

Photo documentation after cleaning

The test surface after cleaning, paints 1-5