BELGIAN BUILDING RESEARCH INSTITUTE
INSTITUTION RECOGNISED BY APPLICATION OF THE DECREE-LAW OF 30 JANUARY 1947

All tests in this report are executed according to the ISO 9001
certified Quality management system of the BBRI

Test Centre — B-1342 Limelette, avenue P. Holoffe 21 — Tel.: +32 (0)2 655 77 11
Offices — B-1932 Sint-Stevens-Woluwe, Lozenberg 7 — Tel.: +32 (0)2 716 42 11
Head Office — B-1000 Brussels, rue du Lombard 42 — Tel.: +32 (0)2 502 66 90

TEST REPORT

Laboratory CAR	**O/References**	DE 651 XM 572 CAR 15203/2_EN Page 1/17

Requested by	**Aluminco Belgium** Jan de Meuterstraat 26 B- 1860 Meise		
Date of the order	2016.01.20	**Samples registration**	S2016-11-016
		Date of reception of samples	2016.02.19
Date of the test	2016.02.22-23-25-26		
Date of issue of the report	2016.03.11		
Test carried out	Static and dynamic tests on balustrade elements		
References	*NBN B03-004 : Balustrade of buildings (2010)* *NBN/DTD B03-004: Balustrade of buildings (February 2015)*		

This test report contains 17 pages with 1 appendix. This test report may only be reproduced in its entirety. Each page of the original report has been stamped (in red) by the laboratory and initialled by the head of laboratory. The results and findings are only valid for the tested samples.

- ☐ *No sample*
- ☑ *Sample(s) subjected to destructive test*
- ☐ *Sample(s) to be removed from our laboratories 30 calendar days after sending of the report, save in the case of a further written request*

Ing. I. Knoops
Responsible of the tests

Ir. V. Detremmerie
Head of laboratory

1 INTRODUCTION

At request of the company Aluminco Belgium, represented by Mr. Ramout Rudy, the laboratory CAR of the BBRI has carried out dynamic and static linear and punctual horizontal loads on a balustrade element. The results of these tests are given in the report with reference “CAR 15203/2_EN”.

2 DESCRIPTION OF THE TEST PIECES

The test pieces were received at the research centre of the BBRI in Limelette on the 19th of February 2016 and were registered in the receipts register of test pieces under the number S2016-11-016 by the laboratory “Roof and Façade elements”. It concerns balustrade elements for which the composition and dimensions are stated below.

2.1 SCHEMATIC REPRESENTATION OF THE TEST PIECES

The schematic representation of the test pieces is shown on *Figure 1*.

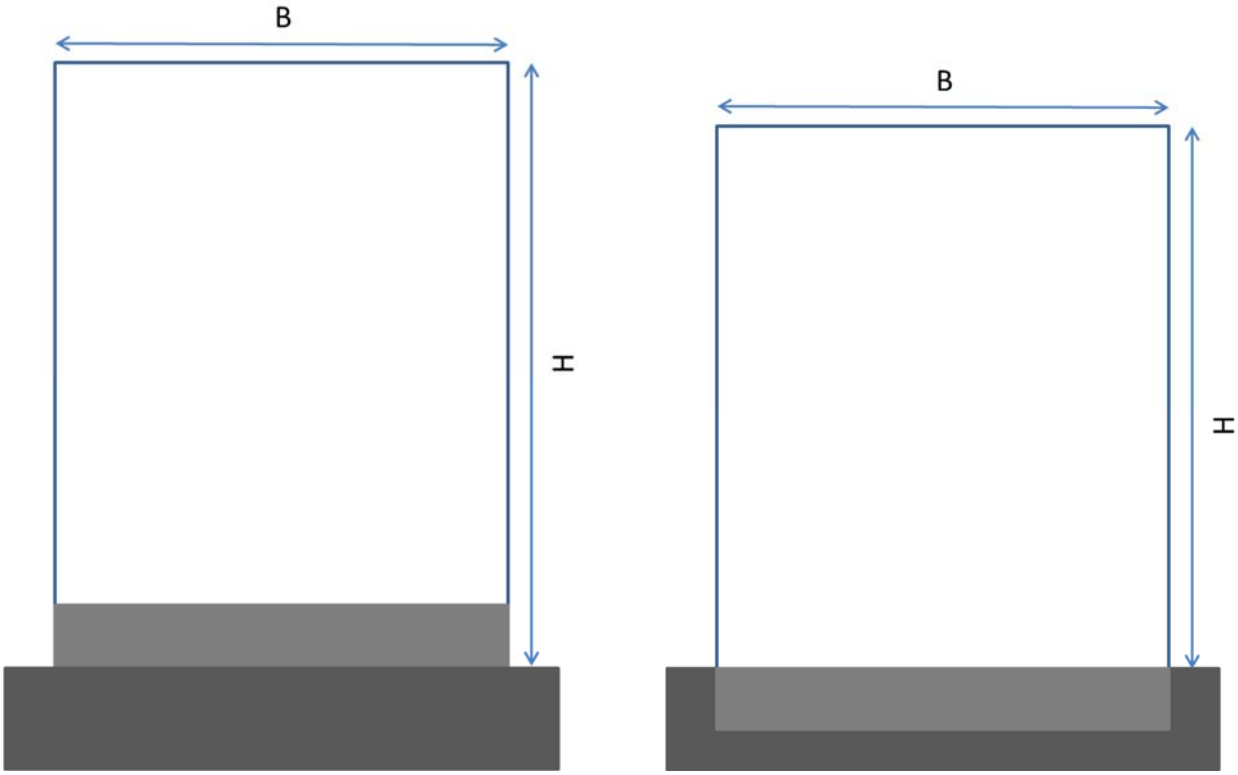


Figure 1: Schematic representation of the test piece: top mount (left) and side mount (right)

2.2 DIMENSIONS OF THE TEST PIECES

The dimensions of the test pieces are given in Table 1.

Type profile	Type of glass	Dimensions of the glass (mm)		Protection height H (mm)
		Height (mm)	width (mm)	
A20 (top)	88.2 DG 41 float	1200	1000	1200
Dc (side)	88.2 DG 41 float	1360	900	1200
	1010.2 DG 41 float	1360	900	1200
L-line Top Mount	88.2 DG 41 float	1200	1000	1200
	1010.2 DG 41 float	1200	1000	1200
L-line Side Mount	88.2 DG 41 float	1300	1000	1200
	1010.2 DG 41 float	1300	1000	1200

Table 1: Dimensions of the used test pieces

2.3 DESCRIPTION OF THE TEST PIECES

The characteristics of the elements constituting the test pieces are given by the applicant and are described here below:

- Mechanical anchoring to the concrete beam via an aluminium profile (top or side)
- Drawings: the cross-sections of the aluminium profile are given in the appendix

3 DESCRIPTION OF THE TESTS

The object of the test is to verify the behaviour of the balustrade under:

- Static loads: horizontal outwardly directed static service and safety loads (linearly distributed and point horizontal loads) and vertical downwards directed static service and safety loads (point vertical loads). These loads must be combined with the wind loads (see table 2)
- Dynamic load: soft body impact test

The loads and their combinations for the static tests on the one hand and the drop height for the soft body impact test on the other hand, are described in the NBN B 03-004 “Balustrades of buildings" (2010). The requirements for residential buildings were used.

After the static tests under horizontal loads, the element must meet the following criteria[1]:

- Service:
  - Under load: deformation of the glass ≤ H/60 or maximum 20 mm (*25 mm*[2]). H is the protection height of the balustrade expressed in mm. The deformation is measured at the level of 1000 mm of the balustrade.

[1] Between brackets and italics, the updated criteria according to the NBN/DTD B03-004
[2] Absolute value. No more criteria in relation to the balustrade height.

  - Residual deformation ≤ 3 mm
- Security: Residual deformation ≤ H/125 (≤10 *mm*[3]*)* with H the protection height in mm

If this is not the case, there's a reason to repeat the test and the measurements. If after 3 successive tests the criteria are not met, the balustrade does not satisfy the quality requirements.

After the impact test, the following criteria must be met:
- The filling element may not separate from the structure of the balustrade.
- No fragments that could injure persons may become detached.
- The impact body must not pass through the balustrade upon impact.
- After the impact, the passage of the hexagonal calibre as defined in 5.4.1.3 of the NBN B03-004 may not be possible (under a negligible force) for the balustrades without panel.
- After the impact, it must not be possible for the balustrades with filling panels to allow the passage of a steel ball with a diameter of 76 mm.

		referentiehoogten ze											
		Wind - blootstellingsklasse 1				Wind - blootstellingsklasse 2				Wind - blootstellingsklasse 3			
Referentiesnelheid	$vb,0\ (m/s)$	26	25	24	23	26	25	24	23	26	25	24	23
Ruwheidscategorien		referentiehoogten (ze) tot				referentiehoogten (ze) tot				referentiehoogten (ze) tot			
Kustgebied	0												
Platteland	I									2m	2m	4m	5m
Wallenlandschap	II			2m	3m	3m	3m	4m	6m	5m	6m	8m	11m
Voorstad - Bos	III	5m	6m	7m	9m	9m	12m	15m	19m	15m	19m	21m	21m
Stad	IV	15m	17m	21m	25m	25m	30m	30m	30m	30m	30m	30m	30m
Dyn. piekdruk	$qp(ze)$=	544 Pa				693 Pa				815 Pa			
		Wind - blootstellingsklasse 4				Wind - blootstellingsklasse 5				Wind - blootstellingsklasse 6			
Referentiesnelheid	$vb,0\ (m/s)$	26	25	24	23	26	25	24	23	26	25	24	23
Ruwheidscategorien		referentiehoogten (ze) tot				referentiehoogten (ze) tot				referentiehoogten (ze) tot			
Kustgebied	0	3m				5m				8m			
Platteland	I	4m	5m	8m	11m	7m	10m	14m	22m	12m	14m	27m	42m
Wallenlandschap	II	8m	11m	15m	16m	14m	16m	16m	22m	16m	16m	27m	42m
Voorstad - Bos	III	21m	21m	21m	21m	21m	21m	21m	22m	21m	21m	27m	42m
Stad	IV	30m	30m	30m	30m	30m	30m	30m	30m	30m	30m	30m	42m
Dyn. piekdruk	$qp(ze)$=	950 Pa				1086 Pa				1224 Pa			
		Wind - blootstellingsklasse 7											
Referentiesnelheid	$vb,0\ (m/s)$	26	25	24	23								
Ruwheidscategorien		referentiehoogten (ze) tot											
Kustgebied	0	15m											
Platteland	I	21m	31m	48m	78m								
Wallenlandschap	II	21m	31m	48m	78m								
Voorstad - Bos	III	21m	31m	48m	78m								
Stad	IV	30m	31m	48m	78m								
Dyn. piekdruk	$qp(ze)$=	1364 Pa											

Table 2: wind class following NBN/DTD B 03-004 (February 2015)

[3] Absolute value. No more criteria in relation to the balustrade height.

4 RESULTS OF THE TESTS

The results in blue and bold satisfy the demands of the NBN/DTD, but do not satisfy the demands of the current NBN. The results in red and bold do not satisfy.

4.1 PROFILE TYPE A20 (TOP MOUNT)

4.1.1 STATIC TESTS

The results of the executed static tests are summarized in table 3.

A20					
Service					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (mm)	
				Deformation of the glass (20 mm NBN; 25 mm NBN/DTD)	Residual deformation (3 mm)
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	0	19,550	1,744
	A	$Q_{kh,1}$: 0,5 kN	0	**26,868**	2,036
	A	$Q_{kh,1}$: 0,5 kN	0	**23,579***	0,348
	A	$Q_{kh,1}$: 1 kN	0	**39,605**	2,975
Security					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (permitted max. deformation)	
				Residual deformation (H/125 = 9,6mm)	
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	0	1,758	
	A	$Q_{kh,1}$: 0,5 kN	0	0,739	

Table 3: Results of the static tests

with $q_{k,h}$: uniform horizontal linear load applied at the level of 1000mm[4]
$Q_{kh,1}$: punctual horizontal load for the local verification at the level of 1000mm[3]

* After adaptation of the profile (see picture 1)!

4.1.2 DYNAMIC TESTS

The results of the executed dynamic tests are summarized in table 4.

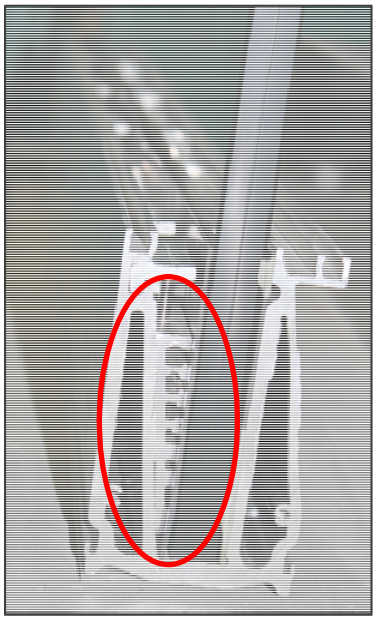
Type of glass	Drop height (mm)	Point of impact	Remarks
88.2 DG41	300	In the corner of the glass panel.	OK, satisfies the criteria in § **Error! Reference source not found.**

Table 4: Results of the impact test

[4] From the finished floor

4.1.3 CONCLUSION

The tested balustrade (A20 (top mount), with a glass 88.2 DG 41 float) satisfies the demands of the **NBN/DTD B03-004** for *residential buildings without wind load* **when a glazing block is put at the edges of the glass** (see picture 1).



Picture 1: extra glazing block at the edge

4.2 PROFILE TYPE DC (SIDE MOUNT)

4.2.1 STATIC TESTS

The results of the executed static tests are summarized in table 5.

Dc					
Service					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (mm)	
				Deformation of the glass (25 mm NBN/DTD)	Residual deformation (3 mm)
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	0	14,166	0,171
	A	$Q_{kh,1}$: 0,5 kN	0	15,351	0,086
1010.2 DG41 float	A	$Q_{kh,1}$: 0,5 kN	0	OK, see 88.2 DG41 float	
	B	$q_{k,h}$: 1 kN/m	0	11,645	0,040
Security					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (permitted max. deformation)	
				Residual deformation (H/125 = 9,6mm)	
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	0	0,444	
	A	$Q_{kh,1}$: 0,5 kN	0	**Broken after 5 min.**	
1010.2 DG41 float	A	$Q_{kh,1}$: 0,5 kN	0	0,595	
	B	$q_{k,h}$: 1 kN/m	0	**Broken after 1 sec.**	

Table 5: Results of the static tests

with $q_{k,h}$: uniform horizontal linear load applied at the level of 1000mm[5]
$Q_{kh,1}$: punctual horizontal load for the local verification at the level of 1000mm[3]

4.2.2 DYNAMIC TESTS

No dynamic tests were executed.

4.2.3 CONCLUSION

The tested balustrade (Dc (side mount), with a glass 88.2 DG 41 float) **DOES NOT** satisfy the demands of the **NBN/DTD B03-004** for *residential buildings without wind load* for the statistic tests.

The tested balustrade (Dc (side mount), with a glass 1010.2 DG 41 float) satisfies the demands of the **NBN/DTD B03-004** for *residential buildings without wind load* for the statistic tests.

[5] From the finished floor

4.3 PROFILE TYPE L-LINE (TOP MOUNT)

4.3.1 STATIC TESTS

The results of the executed static tests are summarized in table 6.

L-line top					
Service					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (mm)	
				Deformation of the glass (20 mm NBN; 25 mm NBN/DTD)	Residual deformation (3 mm)
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	1	**26,404**	1,281
	A	$Q_{kh,1}$: 0,5 kN	1	17,668	0,661
	A	$q_{k,h}$: 0,5 kN/m	2	20,090*	0,733
	A	$Q_{kh,1}$: 0,5 kN	2	11,235	0,078
1010.2 DG41 float	B	$q_{k,h}$: 1 kN/m	3	**23,206**	2,010
	B	$Q_{kh,1}$: 1 kN	3	**21,475**	0,330
Security					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (permitted max. deformation)	
				Residual deformation (H/125 = 9,6mm)	
88.2 DG41 float	A	$q_{k,h}$: 0,5 kN/m	1	6,374	
	A	$Q_{kh,1}$: 0,5 kN	1	3,045	
	A	$q_{k,h}$: 0,5 kN/m	2	0,762*	
	A	$Q_{kh,1}$: 0,5 kN	2	**Broken after 3 min. 49 sec.**	
	A	$Q_{kh,1}$: 0,5 kN	2	**Broken before full load**	
	A	$Q_{kh,1}$: 0,5 kN	2	**Broken before full load**	
1010.2 DG41 float	B	$q_{k,h}$: 1 kN/m	3	5,190	
	B	$Q_{kh,1}$: 1 kN	3	2,364	

Table 6: Results of the static tests

with $q_{k,h}$: uniform horizontal linear load applied at the level of 1000mm[6]
$Q_{kh,1}$: punctual horizontal load for the local verification at the level of 1000mm[3]

*After adaptation of the profile (see picture 2)!

[6] From the finished floor

4.3.2 DYNAMIC TESTS

The results of the executed dynamic tests are summarized in table 7.

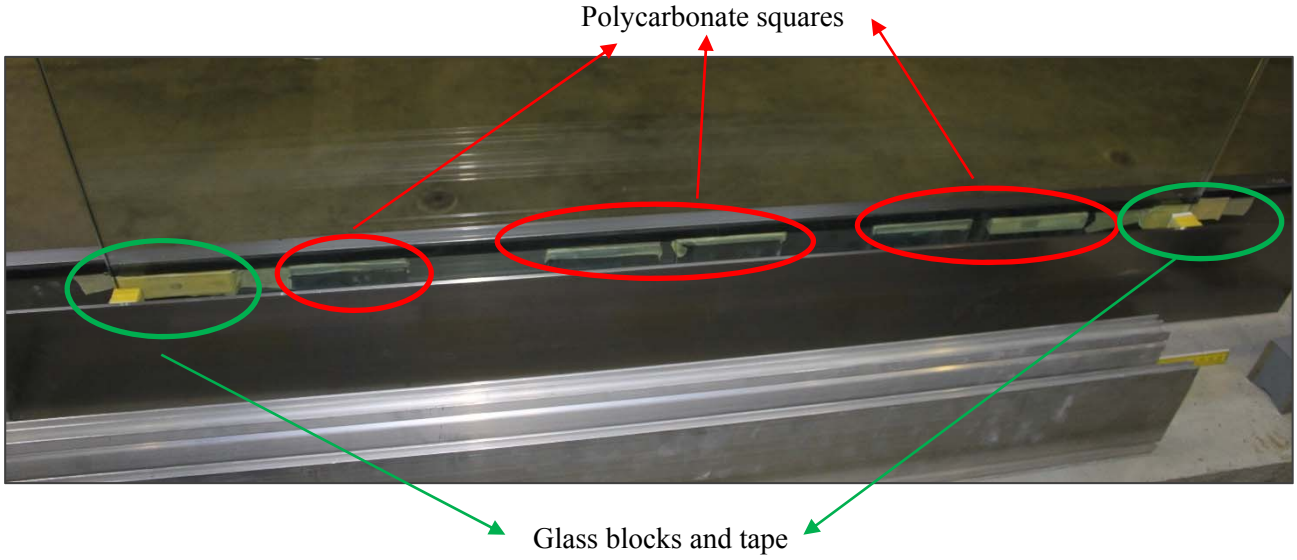
Type of glass	Drop height (mm)	Point of impact	Remarks
88.2 DG41	300	In the corner of the glass panel.	OK, satisfies the criteria in § **Error! Reference source not found.**
1010.2 DG41 float	450	In the corner of the glass panel.	OK, satisfies the criteria in § **Error! Reference source not found.**
1010.2 DG41 float	700	In the corner of the glass panel.	OK, broken but remains in place, satisfies the criteria in § **Error! Reference source not found.**

Table 7: Results of the impact test

4.3.3 CONCLUSION

The tested balustrade (L-line (top mount), with a glass 88.2 DG 41 float) **DOES NOT** satisfy the demands of the **NBN/DTD B03-004** for *residential buildings with wind load class 1.*

The tested balustrade (L-line (top mount), with a glass 1010.2 DG 41 float) satisfies the demands of the **NBN/DTD B03-004** for *residential buildings, office buildings, gathering places (up to C4) and firms with wind load class 3.*



Picture 2: adaptation of the profile with polycarbonate squares, glass blocks and tape. More details are available in pictures 3-7 (side mount).

4.4 PROFILE TYPE L-LINE (SIDE MOUNT)

4.4.1 STATIC TESTS

The results of the executed static tests are summarized in table 8.

L-line side					
Service					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (mm)	
				Deformation of the glass (20 mm NBN; 25 mm NBN/DTD)	Residual deformation (3 mm)
1010.2 DG41 float	B	$q_{k,h}$: 1 kN/m	2	**Deformations too big (+30mm)**	
	B	$q_{k,h}$: 1 kN/m	2	**Extra support: deformations of 25,5mm**	
	B	$q_{k,h}$: 1 kN/m	2	**25,058***	1,421
	B	$q_{k,h}$: 1 kN/m	2	**21,974**	0,406
	B	$Q_{kh,1}$: 1 kN	2	**24,609**	0,560
	B	$Q_{kh,1}$: 1 kN	2	**25,115**	0,220
Security					
Type of glass	Cate-gory	Basic horizontal load for the load combination	Wind class	Criteria (permitted max. deformation)	
				Residual deformation (H/125 = 9,6mm)	
1010.2 DG41 float	B	$q_{k,h}$: 1 kN/m	2	**Broken after 2 min., 30 sec.***	
	B	$q_{k,h}$: 1 kN/m	2	0,677	
	B	$q_{k,h}$: 1 kN/m	2	1,010	
	B	$Q_{kh,1}$: 1 kN	2	**Broken before full load**	
	B	$Q_{kh,1}$: 1 kN	2	0,569	
	B	$Q_{kh,1}$: 1 kN	2	1,783	

Table 8: Results of the static tests

with $q_{k,h}$: uniform horizontal linear load applied at the level of 1000mm[7]
$Q_{kh,1}$: punctual horizontal load for the local verification at the level of 1000mm[3]

*After adaptation of the profile (see pictures 3-7)!

[7] From the finished floor

4.4.2 DYNAMIC TESTS

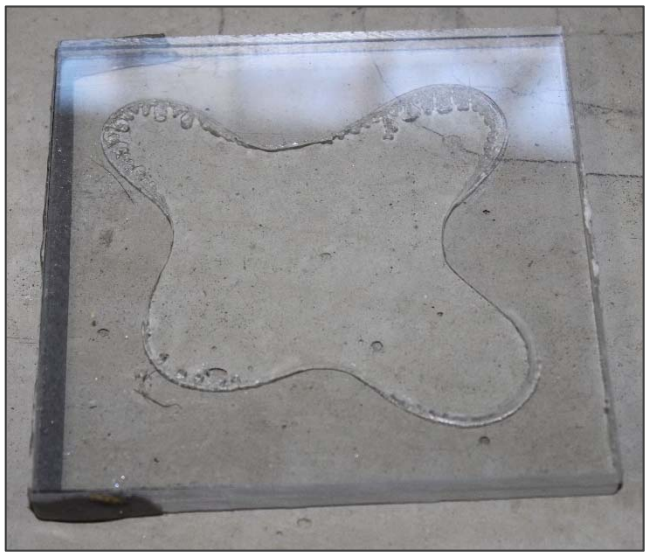
The results of the executed dynamic tests are summarized in table 9.

Type of glass	Drop height (mm)	Point of impact	Remarks
1010.2 DG41 float	450	In the corner of the glass panel.	OK, satisfies the criteria in § **Error! Reference source not found.**, profile is loosened
1010.2 DG41 float	700	In the corner of the glass panel.	**NOT OK, broken into 3 parts**

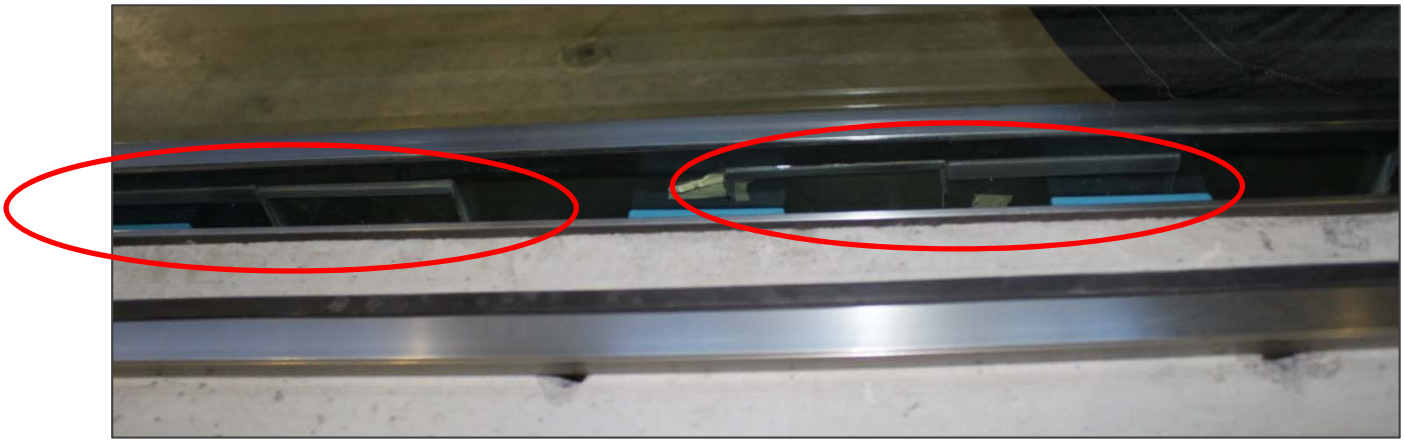
Table 9: Results of the impact test

4.4.3 CONCLUSION

The tested balustrade (L-line (side mount), with a glass 1010.2 DG 41 float) satisfies the demands of the **NBN/DTD B03-004** for *residential buildings and office buildings with wind load class 2* **when the profile is adapted as described in the pictures below**!



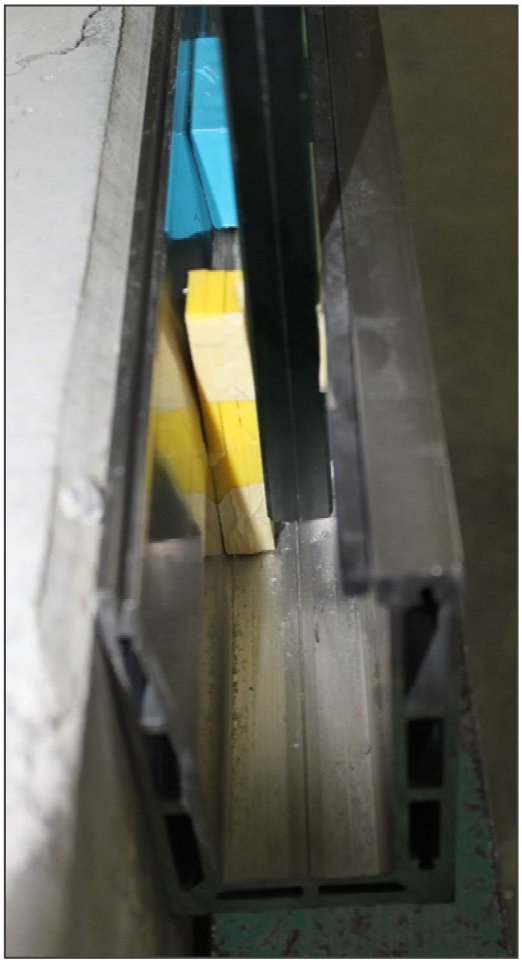
Picture 3: squares made of polycarbonate were introduced into the profile



Picture 4: position of the squares in the profile

Picture 5: glazing blocks were taped together and introduced at the edges of the glass in the profile (left edge)

Picture 6: glazing blocks were taped together and introduced at the edges of the glass in the profile (right edge 1/2)



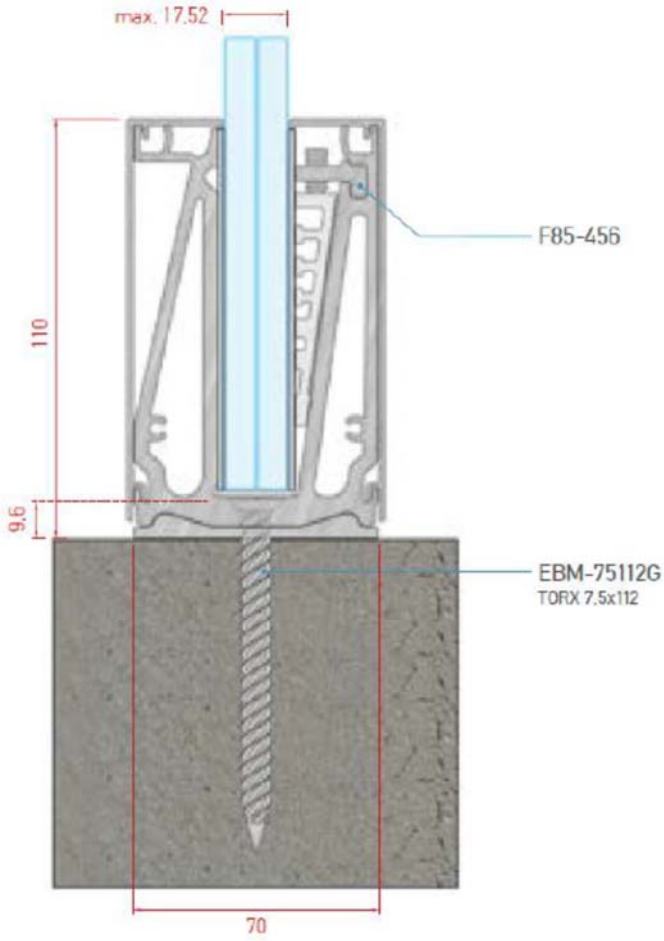
Picture 7: glazing blocks were taped together and introduced at the edges of the glass in the profile (right edge 2/2)

5 APPENDIX

Type A20 | Wedge on floor system

Pose sur dalle avec de profile de sol en une piece

Technical specifications / Specifications techniques



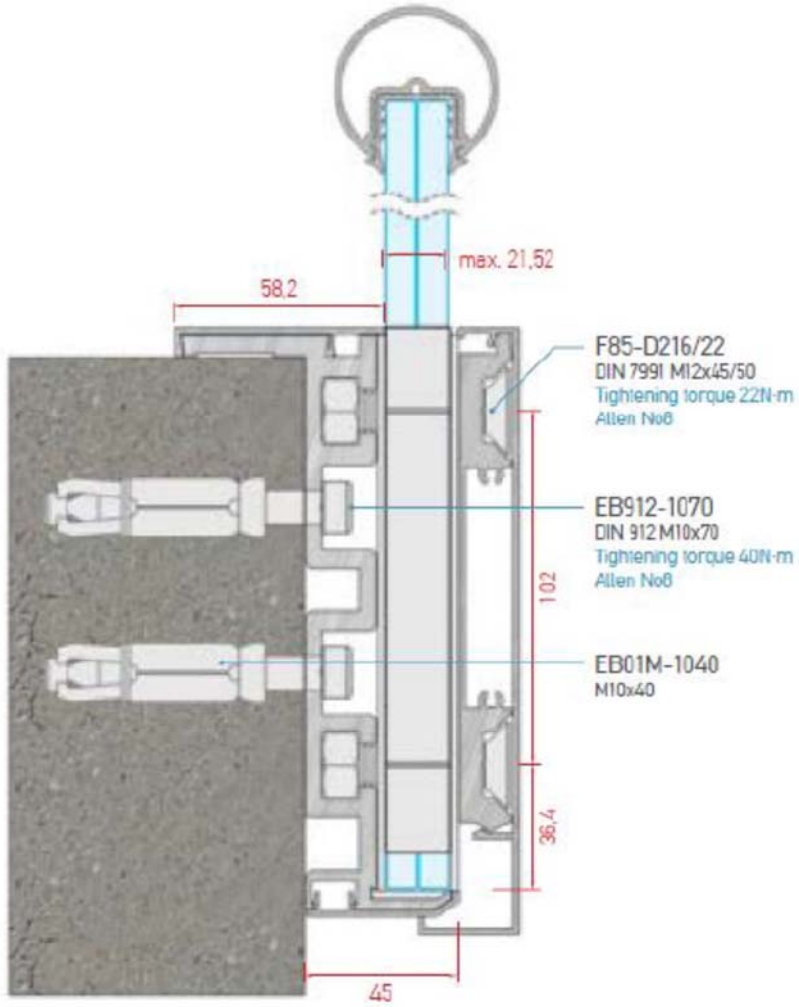
Glass section A20
16mm
Min. 16.76mm
Max. 17.52mm
Recommended glass
17.52mm (8-1.52-8)

Type Dc No Drill

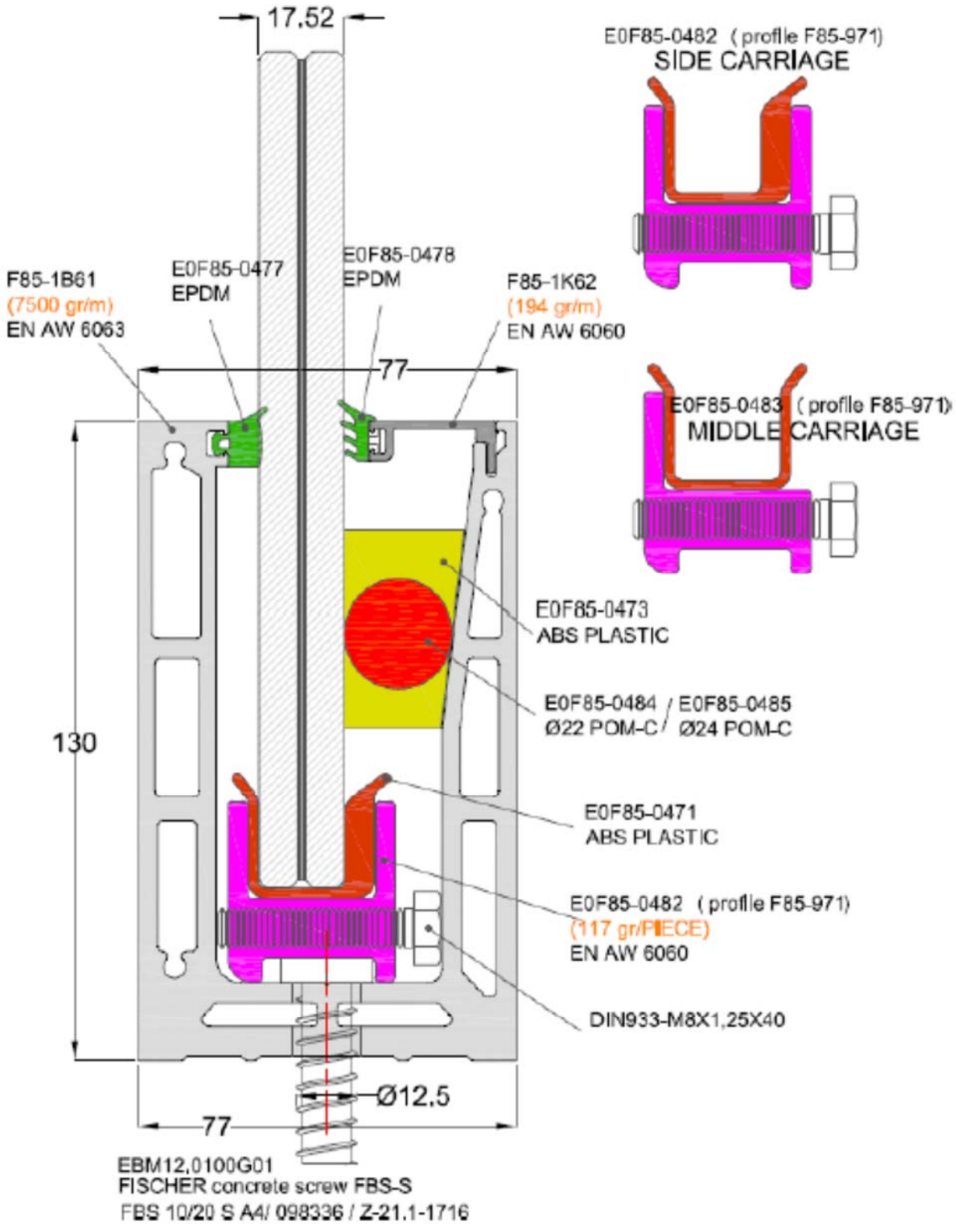
Evolutionary concept of external fascia mounting, without any drilling on the glass panels

Conseption revolution aire sans percer le verre!

Technical specifications / Specifications techniques



CRYSTALINE L-LINE TOP MOUNTED GLASS 8-4PVB-8MM



CRYSTALINE L-LINE SIDE MOUNTED GLASS 8-4PVB-8MM