VERROTEC
Testing, inspection and certification body
(RPF14)

Content: **Test Report**

Project: B + BTEC Pendulum impact test glass balustrade

Project number: VT 21-1125

Report: VT 21-1125 - 01

Contract: Impact tests with twin tires according to DIN 18008-4 on a balustrade system

Client: Boor- + Bevestigingstechniek BV
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Date: 12. April 2021

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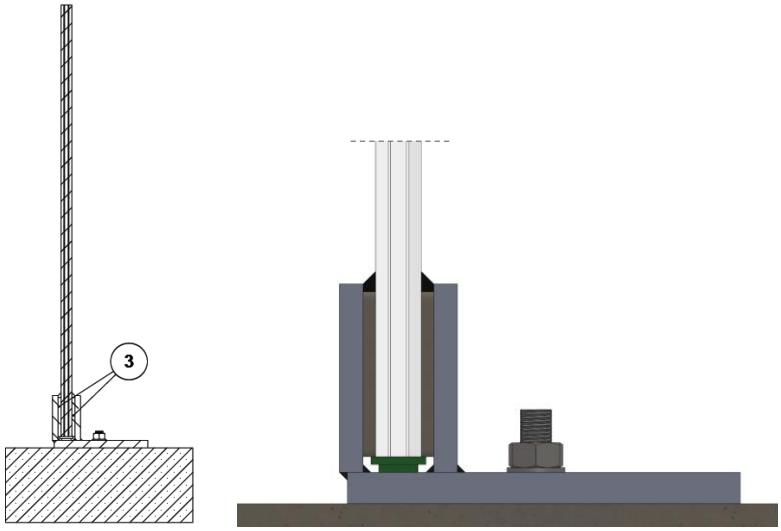

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-	-	12/04/2021

1. General

The company Verrotec GmbH located in Mainz (Germany) was assigned by the company Boor- + Bevestigingstechniek BV, located in 4762 AH Zevenbergen, to verify the balustrade effect of a balustrade system by pendulum impact tests.

In this test report the relevant glass formats with their direct glazing of the substructure are evaluated under impact loading. The glazing must resist the impact load of category A according to the DIN 18008-4.

Subject of this report is only the resistance of the balustrade system under impact loading. The verification of the glass under static loads shall be executed separately.

A transfer of the results of this test report is not permitted, unless within the scope of this report.

2. Remarks

- Material compatibilities are to be verified when using different plastic materials (silicon, PVB, etc.).
- Corrosion of metallic materials has to be prevented by suitable means (e.g. different alloy choice, coating, prevention of contact corrosion, constructive means, etc.). Corrosive categories are to be considered object related.
- Due to material and production related nickel sulphide inclusion, tempered glass is susceptible to spontaneous breakage of glass. We recommend the general use of tempered glass with Heat Soak Test. Due to the additional Heat Soak Test the risk of glass breakage due to nickel sulphide inclusion is considerably minimized.
- A constraint-free bearing of the glass is to be ensured.
- Contact between metal and glass or glass and glass have to be avoided permanently.
- In case of glass breakage the concerned areas are to be secured, the broken glass panes are to be replaced immediately.
- This document is only valid for the tested system. The results of this document are only valid, if the boundary conditions defined in this document are provided on-site. This is to be verified on-site.
- This document is to be published unabridged; partial publication requires the permission of Verrotec GmbH.
- A transfer of the results on other positions or systems is not allowed unless described within this document.
- The company VERROTEC GmbH in Mainz, Germany, takes responsibility only for the tested construction parts under the described preconditions. If there are any changes or discrepancies, we demand notification.
- The written results are intended exclusively for the client, so that no claims can be made by third parties. In addition, Verrotec GmbH does not assume any obligation in favor of third parties or any liability towards third parties from and in connection with the services rendered for the customer.

3. Standards and technical rules

[1] DIN 18008-1 Glass in Building – Design and construction rules – Part 1: Terms and general bases

[2] DIN 18008-2 Glass in Building – Design and construction rules – Part 2: Linearly supported glazing

[3] DIN 18008-4 Glass in Building – Design and construction rules – Part 4: Additional requirements for barrier glazing

4. Plans

The following current plans are the basis of this document:

[4] 21_199_423-1 from 29.03.2021

[5] Steel profile from 29.03.2021

5. Description of the construction

Note: ESG means heat toughened glass and VSG means laminated safety glass (with PVB = Interlayer of polyvinyl butyral).

5.1 General description

The construction to be examined here is a balustrade with a fall protection function. It consists of a substructure made out of steel plates welded together and a laminated safety glass.

5.2 Substructure

The substructure of this balustrade system is made out of steel plates (S355) welded together to an F-shaped profile (see Image 1). The dimensions of the base plate are 250 x 20 [mm]. Two steel plates with the dimensions 120 x 15 [mm] are welded to the base plate.

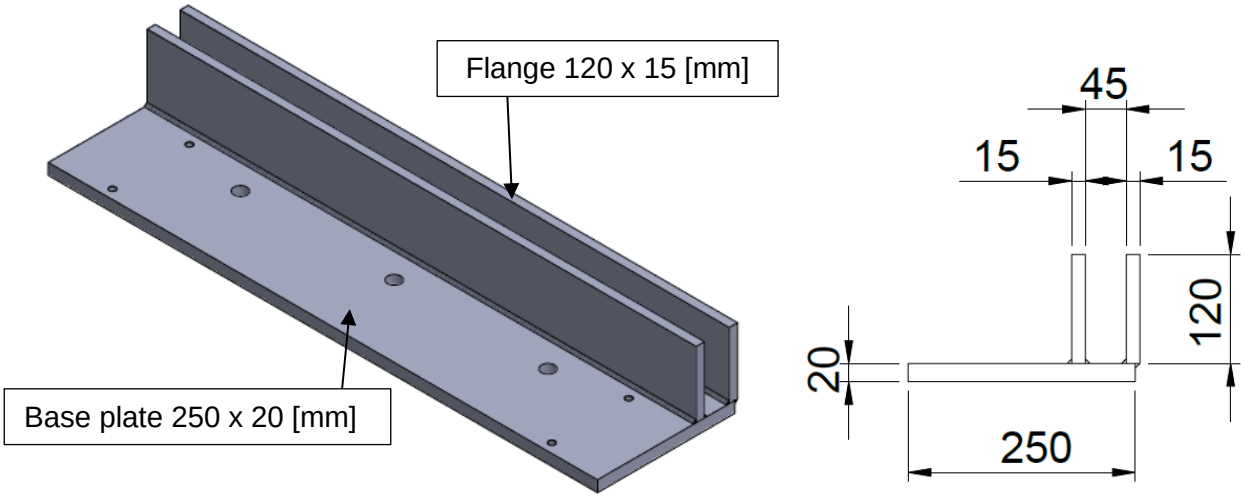

Image 1 Representation of the substructure

The substructure is connected to the concrete by anchors (M20x220 [mm] 8.8, anchoring depth is 140mm). The anchors are glued into the drill holes with B+BTEC BIS-V injection mortar (see Image 6). The distance between the holes for the anchors is 280mm and can be taken from Image 2.

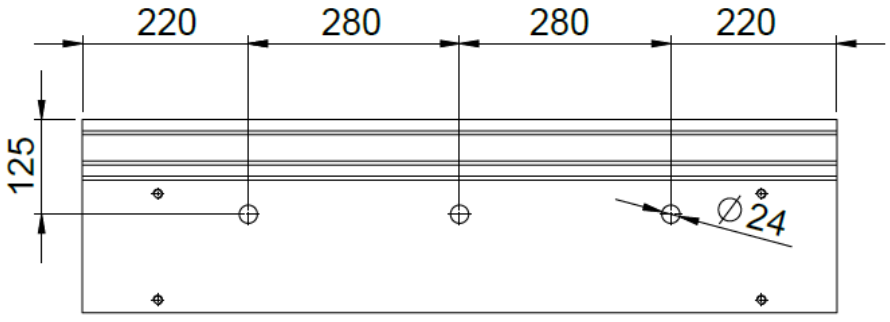

Image 2 Screw distance

5.3 Glazing

The glazing is a laminated safety glass with the following dimensions and glass assembly:

Dimensions:	950 x 1200 [mm]
Glass assembly:	8mm ESG 1,52mm PVB 10mm ESG 1,52mm PVB 8mm ESG

The fixing height of the glass in the steel profile is 110 mm (see Image 3). The dead weight is removed by two glazing blocks.

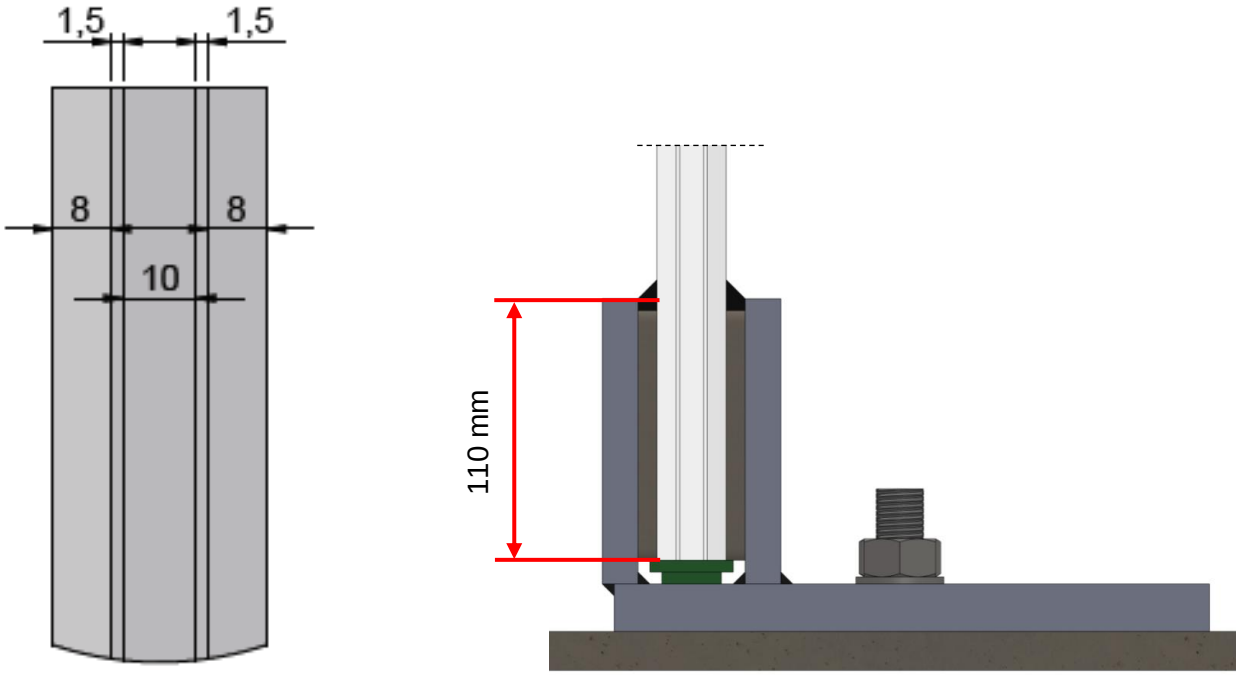

Image 3 Glass assembly and clamping height in the steel profile

6. Pendulum impact tests

6.1 Test setup and procedure

To assess the impact resistance of the glazing and the direct substructure, the decisive panes with substructure according to chapter 5.2 are tested. Pendulum impact tests are carried out according to DIN 18008-4 taking into account the following parameters:

Pendulum:	Twin – tire (acc. to DIN 18008-4)
Weight:	50 kg
Tire pressure:	3,5 bar
Drop height Δh:	900 mm (in accordance with category A)
Substructure:	according to chapter 5.2 and 6.1.1

Image 4 Test setup (left) and fixing height of the glass (right)

6.1.1 Substructure

The substructure tested here is similar to the construction described in chapter 5.2.

The substructure is mounted on a concrete block with 3 anchors (M20x220 [mm] 8.8, anchoring depth is 140mm) with a distance of 280mm (see Image 5).

Image 5 Mounting of the substructure

The anchors are placed 140mm deep into the concrete block and glued with B+BTEC BIS-V injection mortar (see Image 6). The tested concrete strength class is C25/30.

Image 6 B+BTEC BIS-V420 injection mortar

6.1.2 Tested glass formats and assemblies

In order to experimentally verify the impact resistance of the glazing including the substructure, pendulum impact tests are carried out on the test samples shown in the following Table 1.

Table 1 Overview of the glass dimensions and assembly

Sample	Glass assembly (symmetrical)	Glass dimensions B x H [mm]	Substructure
1	ESG 8 mm 1,52 mm PVB ESG 10 mm 1,52 mm PVB ESG 8 mm	950 x 1200	According to chapter 5.2
2			

The glass is stored on two glazing blocks (see Image 7). The clamping of the glass in the substructure is done by three glued points each side (B+BTEC BIS-V injection mortar, see Image 8). The glass depth into the substructure is 110mm.

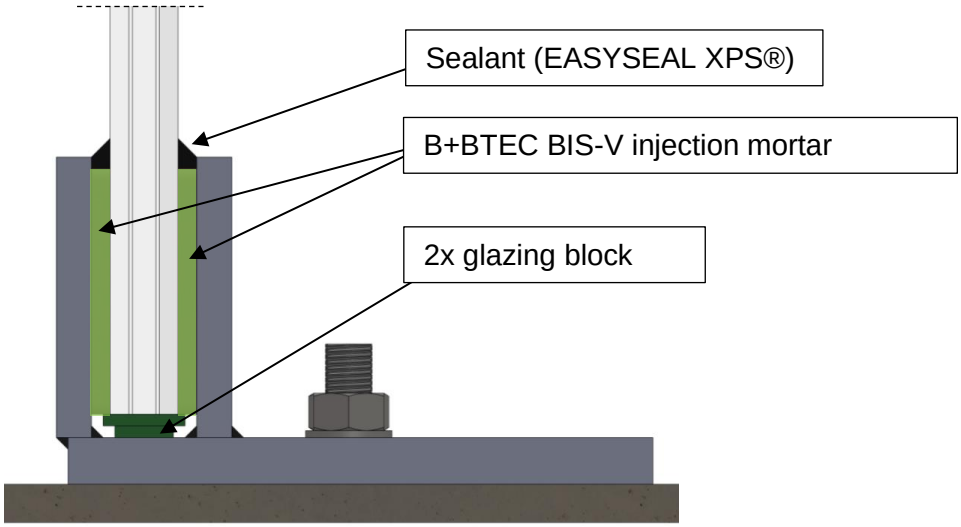

Image 7 Glass clamping

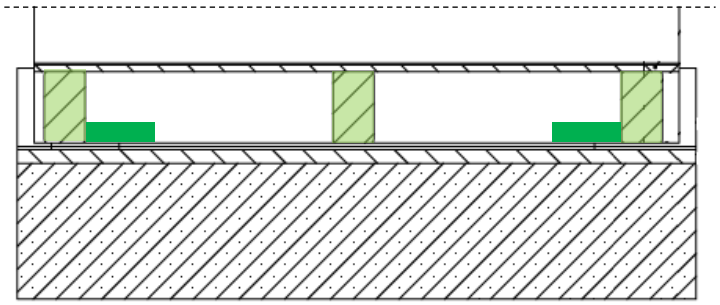

Image 8 Position of the clamping points

6.1.3 Tested impact points

The samples are tested according to the requirement for category A of DIN 18008-4 with a pendulum drop height of Δh = 900mm.

In Image 9 the impact points according to DIN 18008-4 are shown.

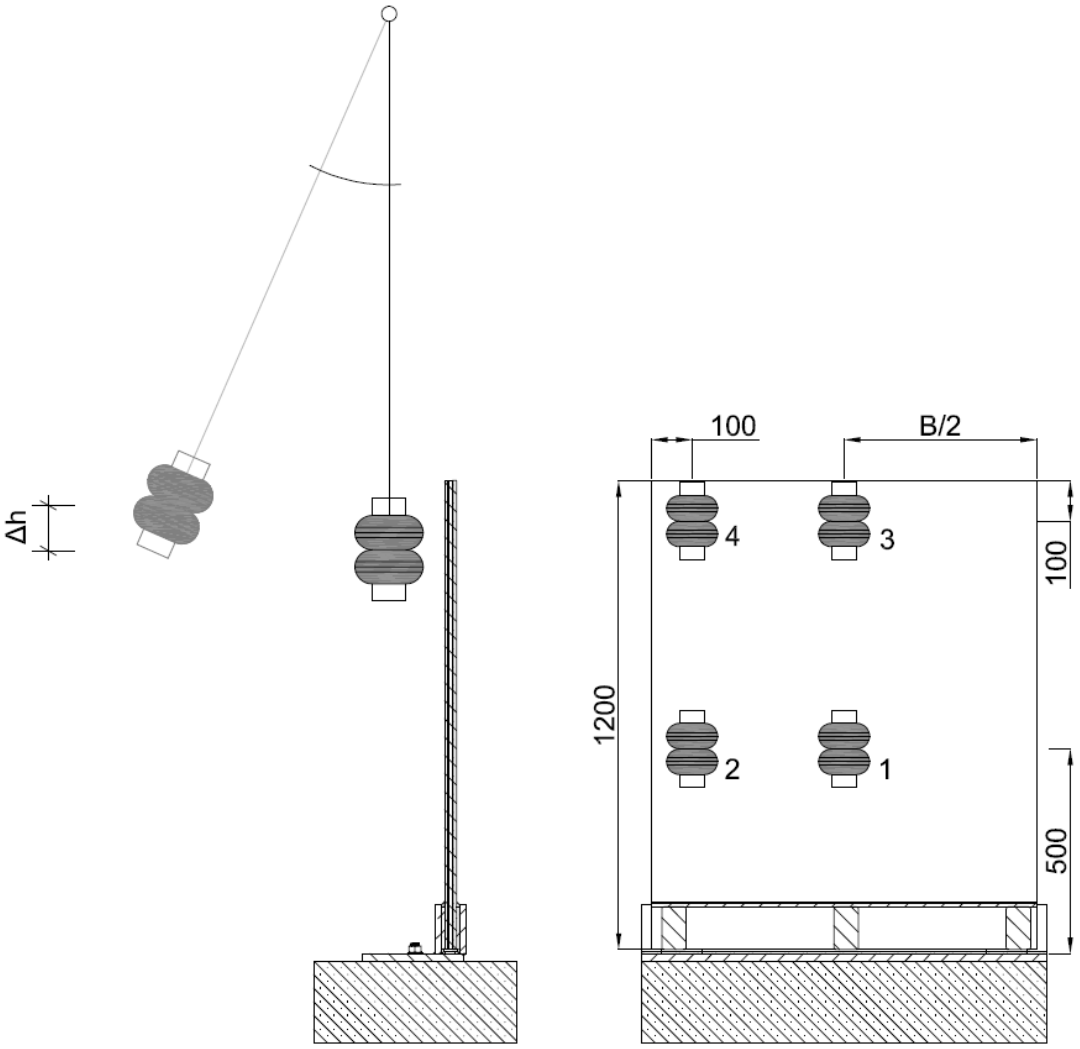

Image 9 Drop height Δh and impact points acc. DIN 18008-4

6.2 Test results

In the following Table 2 the results of the pendulum impact tests are shown.

Table 2 Results of the pendulum impact tests

Sample	Fall height Δh [mm]	Impact Point	Result
1	900	1	▪ No visible damage to the glazing or the substructure
		2	▪ No visible damage to the glazing or the substructure
		3	▪ No visible damage to the glazing or the substructure
		4	▪ Breakage of the inner ESG (see Image 10) ▪ No visible damage to the substructure
	100	4	▪ No other damages to the glazing ▪ No visible damage to the substructure
2	900	1	▪ No visible damage to the glazing or the substructure
		2	▪ No visible damage to the glazing or the substructure
		3	▪ Breakage of the inner ESG pane (see Image 11) ▪ No visible damage to the substructure
		4	▪ No visible damage to the glazing or the substructure
	Striking of the middle ESG pane and additional test with reduced drop height		
	450	3	▪ No other visible damage to the glazing ▪ No visible damage to the substructure

7. Summary

The company Verrotec GmbH located in Mainz (Germany) was assigned by the company Boor- + Bevestigingstechniek BV, located in 4762 AH Zevenbergen, to verify the balustrade effect of a balustrade system by pendulum impact tests.

In this test report the relevant glass formats with their direct glazing of the substructure are evaluated under impact loading. The glazing must resist the impact load of category A according to the DIN 18008-4.

Subject of this report is only the resistance of the balustrade system under impact loading. The verification of the glass under static loads shall be executed separately.

A transfer of the results of this test report is not permitted, unless within the scope of this report.

The tests have shown that the tested balustrade system (glass, direct substructure and fixings) withstands the impact loads in accordance with the category A of DIN 18008-4.

Anhang A Photo documentation

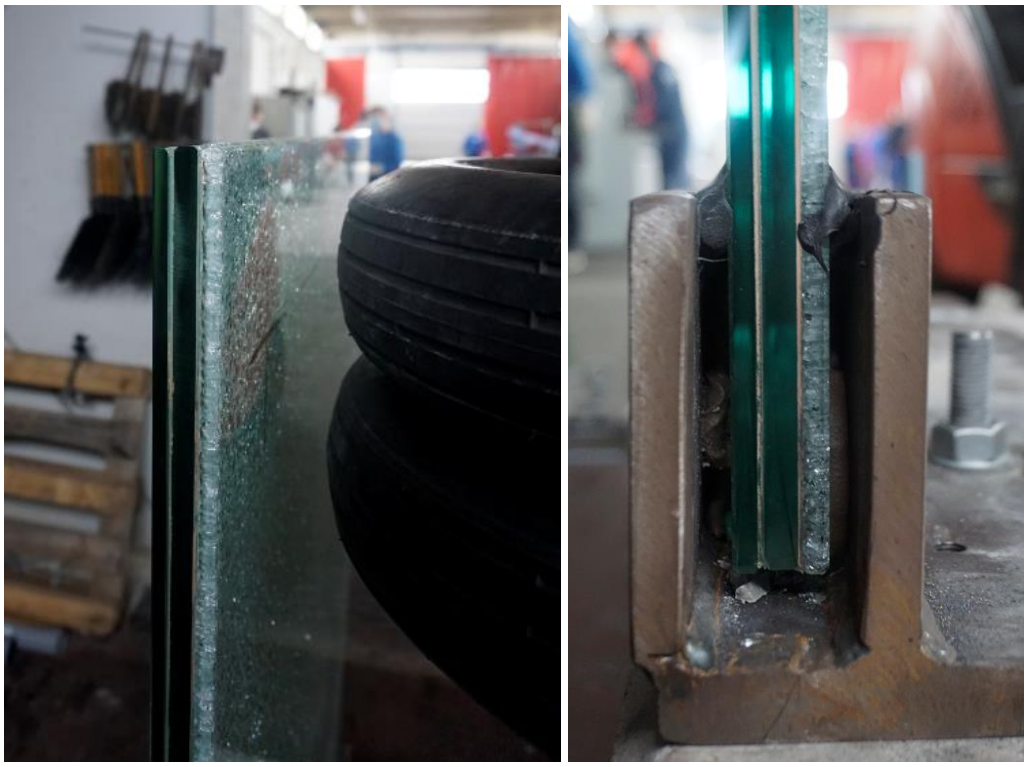

Image 10 Breakage of the inner ESG at impact point 4 (PK1)

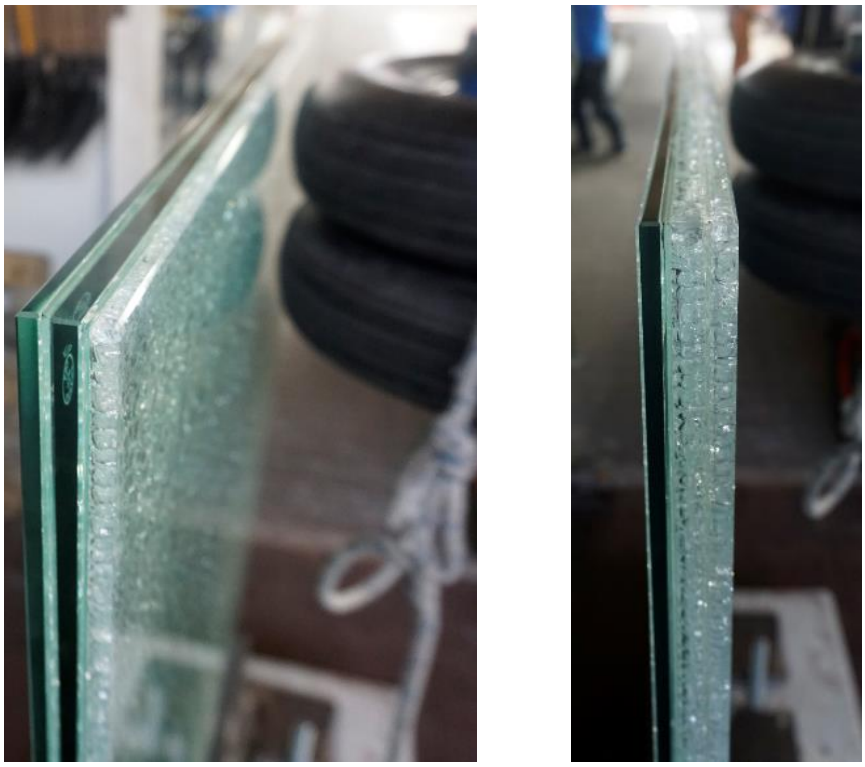

Image 11 Breakage of the inner ESG at impact point 3 (PK2) / breaking of the 10 mm ESG before pendulum with 450 mm fall height (right)

Anhang B Glass installation

Image 12 Glazing blocks and injection point of the adhesive

Image 13 B+BTec Vinylester BIS-V

Image 14 Sealing the glazing using EASYSEAL XPS®