# REPORT

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# Testing of balcony railing

(1 appendix)

## 1 Introduction

On behalf of UMAKOV Group, a. S, RISE has performed tests with static loading and impact tests on a balcony railing.

Purpose: To verify the railing's ability to withstand static load and load from heavy impact by testing.

Test location: RISE laboratory for Applied Mechanics.

## 2 Test object

Designation: Glass railing.

Design: The railing consisted of U-shaped aluminium profile that can either be mounted directly on the top of the balcony floor or the front face of the balcony. In the test, the U-profile was mounted to the test fixture with M10 bolts. In the U-profile a laminated glass that consisted of two pieces of hardened 8 mm glass with an intermediate PVB foil, total thickness 16,78 mm. The tested railing had a width of 1.00 m and a height of 1.10 m above the floor. Drawings of the test objects are presented in Appendix 1.

Sample selection: Performed by the client without RISE assistance.

Arrival date: 01 September 2020.

## 3 Test procedure

Test method: Technical guidance from Balcony association dated February 2019. The implementation of the test is described in section 4 together with the results.

Scope: Six tests with static loading and three tests with heavy impact were conducted.

Test date: 16 - 17 September 2020.

# 4 Implementation and results

## 4.1 Static loading

The tests were performed with both top-mounting and mounting on the balcony front. Figure 1 and 2 below show the test setups. The static load tests were conducted with a line load which was applied in the top of the railing. The load was increased continuously with a rate of 0,5 kN per minute until the required level or until failure. The deflection at the serviceability limit state was registered. The results from the tests are presented in Table 1 below.

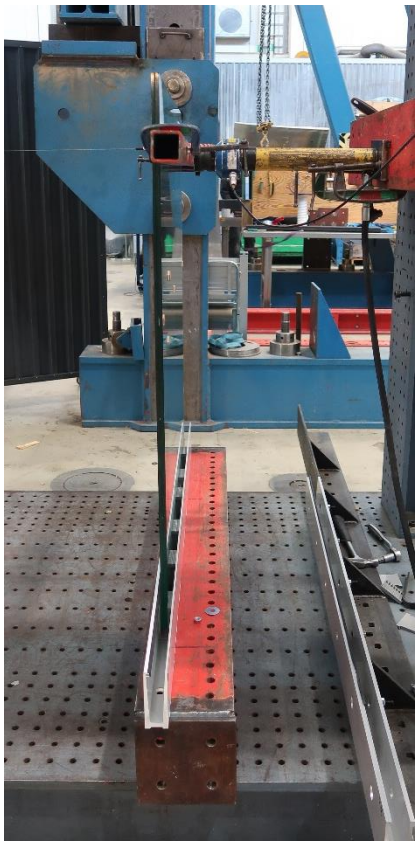

*Figure 1 and 2 Test setups for static load test.*

*Table 1 Result from static load test.*

| Test no | Type of railing | Load class $q_k$ (kN/m) | Failure load* (kN/m) | Deflection at $q_{adm}$=0,5 $q_k$* (mm) | Fulfill requirements |
|---|---|---|---|---|---|
| 1 | Top-mounted | 1,0 | > 1,7 | 20,9 | Yes |
| 2 | Top-mounted | 1,0 | > 1,7 | 21,9 | Yes |
| 3 | Top-mounted | 1,0 | > 1,7 | 20,7 | Yes |
| 4 | Front-mounted | 0,5 | > 1,7 | 17,2 | Yes |
| 5 | Front-mounted | 0,5 | > 1,7 | 16,6 | Yes |
| 6 | Front-mounted | 0,5 | > 1,7 | 18,5 | Yes |

* Requirement for failure load is $q_k$ × 1,5 and at serviceability load ($q_{adm}$) the permissible deflection is 30 mm.

## 4.2 Heavy impact

The impact testing was performed according to applicable parts of SS-EN 12600. Note that the test procedure is adapted to the test object. Figure 3 below shows the test setup.

The test object was mounted onto the mounting fixture according to the client's instructions. The 50 kg impactor hit the glass infilling from the inside and in its centre, vertical drop height 450 mm. Visual inspection was performed after the impacts. The top-mounted was the stiffest of the two mounting types, and therefore the impact tests were performed with this type of mounting since it gives the highest strain on the glass. The results from the tests are presented in Table 2 below.

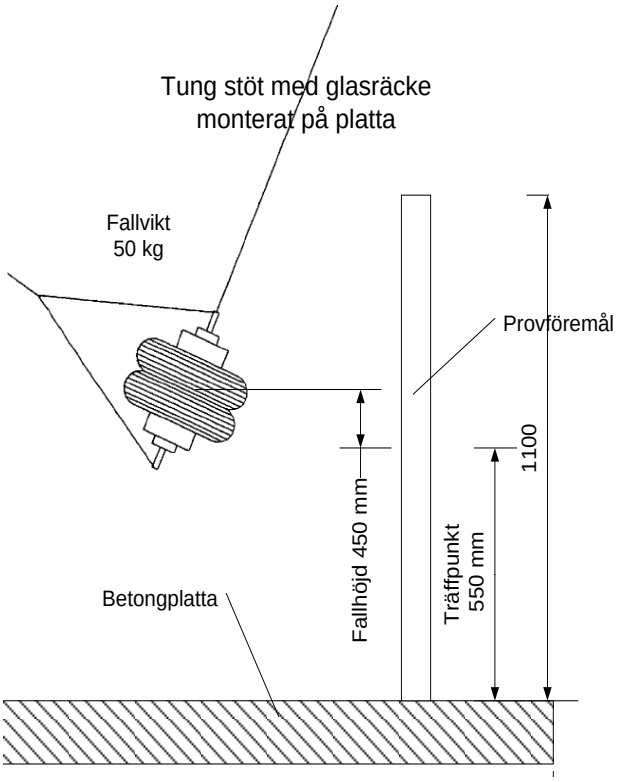


*Figure 3 Test setup heavy impact.*

*Table 1 Result from heavy impact test.*

| Test no | Type | Observations | Requirement fulfilled |
|---|---|---|---|
| 1 | Top-mounted | No damage | Yes |
| 2 | Top-mounted | No damage | Yes |
| 3 | Top-mounted | No damage | Yes |

The results apply solely to the tested objects.

# 4 Measurement uncertainty

Measurement uncertainty when measuring the load, deflection and impact energy is estimated to < 1.0 % of the reported value.

Reported uncertainty corresponds to an approximate 95 % confidence interval around the measured value. The interval has been calculated in accordance with EA-4/16 (EA guidelines on the expression of uncertainty in quantitative testing) which is normally accomplished by quadratic addition of the actual standard uncertainties and multiplication of the resulting combined standard uncertainty by the coverage factor *k*=2.

# 5 Judgement

The tested railing type with top-mounting and front-mounting fulfill the strength requirement according to the Technical guidance from Balcony association dated February 2019 as follows.

Top-mounted: Fulfill the requirements for building category C2 – C4 och D.

Frontal mounted: Fulfill the requirements for building category A, B och C1.

**RISE Research Institutes of Sweden AB**
**Department Applied Mechanics, RISE AB - Construction and Infrastructure**

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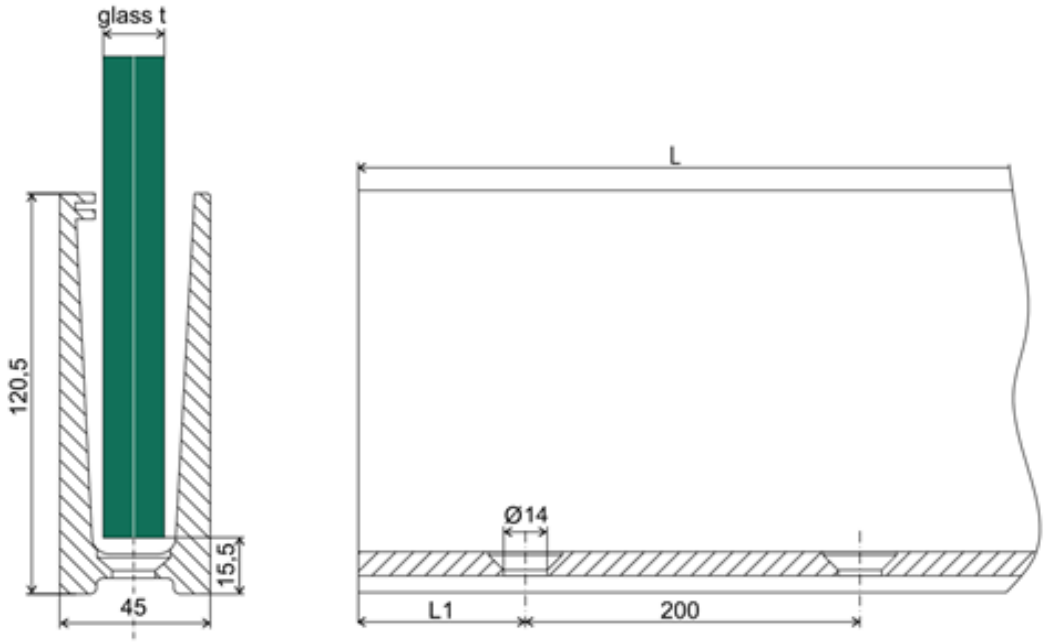
**Appendix**

1 Drawing (1 page)

Appendix 1

Profile for top-mounting




Profile for frontal-mounting