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Dresden, 13 May, 2015

Test Report No. 2613108

Client:

Bruag AG
Bahnhofstrasse 8
8594 Guettingen, SWITZERLAND

Date of order:

12 May, 2015

Order:

Test of a balcony parapet system according to ETB Guideline "Fall prevention components"

Contractor:

Entwicklungs- und Prueflabor Holztechnologie GmbH

Engineer in charge:

Dipl.-Ing. J. Gecks

Dr.-Ing. B. Devantier

Head of Laboratory Material and Product Testing

The test report contains 5 pages. Any duplication, even in part, requires written permission of EPH. These test results are exclusively related to the tested material.

1 Terms of Reference

Entwicklungs- und Prüflabor Holztechnologie GmbH (EPH) was ordered by Bruag AG resident in Guettingen, Switzerland to test a balcony parapet system regarding its fall protection. The tests regarding soft and hard impact were carried out according to ETB Guideline "Fall prevention components", §§ 3.2.2 and 3.2.3 (ETB: Introduced Technical Building Regulation in Germany).

2 Test Material

Bruag AG sent 4 balcony parapets to the laboratory. The material arrived on 12 May, 2015. Drawings of the parapet system were not available. The following parapet system was tested:

- 10 mm thick CELLON Compact Board without edge profile, dimension: 2375 mm x 1175 mm, perforation on 40 % of the board area (round holes, minimum distance between the holes: 14 mm, maximum diameter of the holes: 40 mm)
- the board is fixed on a steel frame (8 fastening points on the outer surrounding frame, 2 fastening points on the central bar)
- fastening on the outer profile with threaded screws, steel quality: 8.8, thread diameter: M6, shaft length: 80 mm, fastened with nut
- fastening on central bar with threaded screws, steel quality: 8.8, thread diameter: M6, shaft length: 35 mm, screwed in the central bar
- washer with an outer diameter of 20 mm, under each head of screw
- distance between the screws on the vertical profiles of the frame: 570 mm, inside the central bar: 400 mm
- dimensions of the welded steel frame: 2400 mm x 1200 mm, circumferential angle profile 65/70/7, profile of central bar 50/10 (rectangular)
- compact board on the outside of parapet.

The test assemblies were numbered from 101 to 104. Figures 1 and 2 show photos of the balcony parapet system before the test.



Figure 1: Balcony parapet system, inside

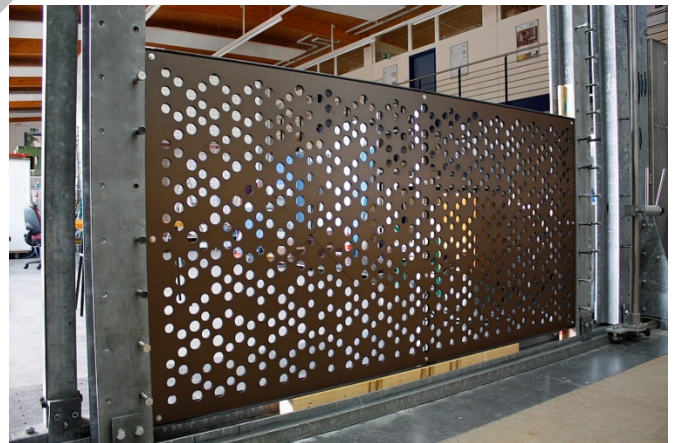


Figure 2: Balcony parapet system, outside

3 ETB Guideline and Test Procedure

3.1 Determination of the Impact Energy by Evidence by Testing according to § 3.2.2.2.2 of ETB Guideline

The ETB Guideline specifies in § 3.2.2.2.2 *Evidence by Test* as part of § 3.2.2.2 *Determination of Impact Energy* the following:

The numerical evidence can be replaced by bending test. In this case, the decisive value E_{test} (absorbed energy during the test, until the test assembly fails) shall be opposed to the proportional energy $\alpha' \cdot E_{\text{basis}}$ as follows:

The following evidence shall be provided¹:

$$E_{\text{test}} \geq v \cdot \alpha' \cdot E_{\text{basis}}$$

with:

$v = 1.25$ coefficient for assurance against scattering which are not covered by the tests

α' impact coefficient depending on the mass of the element
 mass of tested system < 50 kg $\rightarrow \alpha' = 1.0$
 (see Table 1 in the Guideline)
 E_{basis} = impact energy as a result of soft impact, acc. to the Guideline = 100 Nm

Thus, the parapet systems shall meet the following requirement for the impact energy E_{test} :

$$E_{\text{test}} \geq 1.25 \cdot 1.0 \cdot 100 \text{ Nm} \geq 125 \text{ Nm}$$

The impact energy E_{test} will be calculated according the following equation using the mean value E_u (calculated from the measured values and divided by a safety factor):

$$E_{\text{test}} = E_u / \gamma$$

The safety factor can be estimated using the following equation:

$$\gamma = (1 + (s_E / E_u)^2)^{1/2} \cdot \exp(K \cdot s_E / E_u)$$

with E_u as mean value and s_E as standard deviation of the measured values and $K = 0.9$.

The parapet systems were clamped into a test rig that the real assembly situation could be simulated (see Figure 3 and Figure 4). The load was applied using a circular steel disc with a diameter of 200 mm. The steel disc was coated with a 8 mm thick rubber pad of a Shore A hardness of approximately 80. The load was applied at the geometrical center of one section of the parapet system. The deformation of the compact board was measured during the test at several force ranges. The maximum cylinder stroke was 200 mm, the maximum applicable load 10 kN.

¹

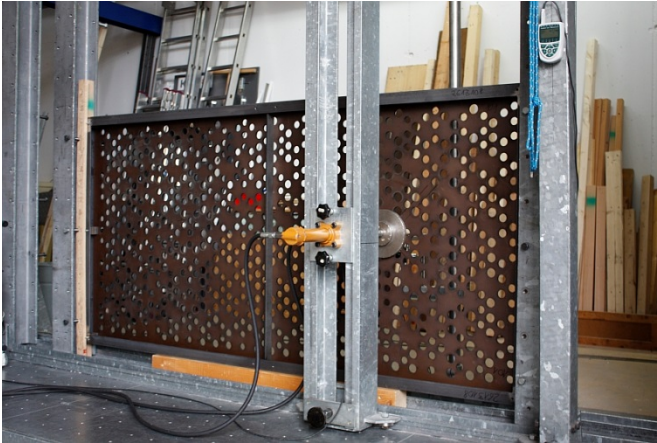


Figure 3: Test assembly, load point

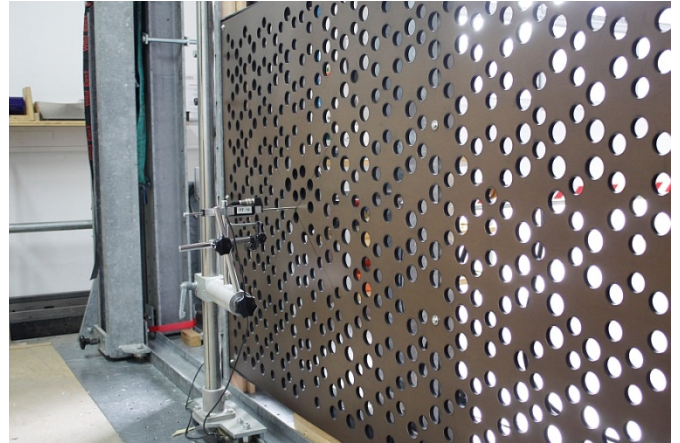


Figure 4: Prüfaufbau, measurement of deformation

3.2 Hard Body Impact Test according to § 3.2.3 of ETB Guideline

The hard body impact test was carried out by free fall of a steel ball with a diameter of 63.5 mm and a mass of 1 kg from a height of 1 m. The parapet system (test assembly no. 104) laid freely movable. According to the ETB guideline, § 3.2.3, the test was carried out on 15 positions of the compact board.

4 Test Results

4.1 Determination of the Impact Energy by Evidence by Testing according to § 3.2.2.2.2 of ETB Guideline

Table 1: Test results

Test assembly	F in kN	δ_{\max} in mm	E_{test} in Nm	Note
101	4.0	67.0	134	The system failed at the fastening points of the compact board to the frame profile. The failure is shown in Figure 5 and Figure 6.
102	3.9	64.2	125	
103	4.3	60.1	129	

$$E_u = 129 \text{ Nm}$$

$$s_E = 4.5 \text{ Nm}$$

$$\gamma = 1,03$$

$$E_{\text{test}} = 125.2 \text{ Nm} > 125 \text{ Nm}$$



Figure 5: Failure of test assembly no. 101 at the fastening point at the maximum load of 4 kN (interior view)

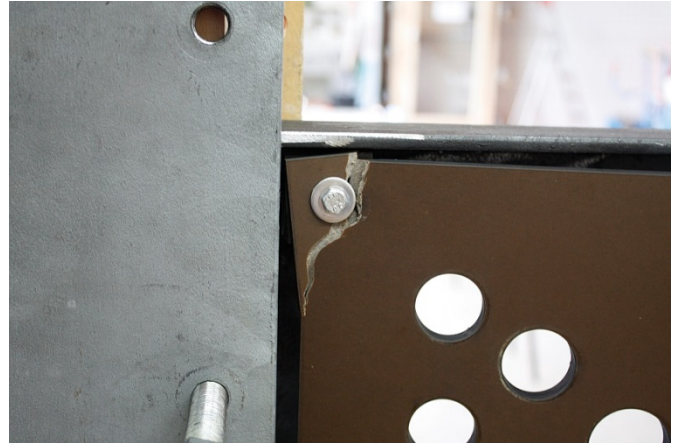


Figure 6: Failure of test assembly no. 101 at the fastening point at the maximum load of 4 kN (exterior view)

4.2 Hard Body Impact Test according to § 3.2.3 of ETB Guideline

The parapet system met the requirement regarding hard body impact according to ETB Guideline, § 3.2.1. There were no damages identified by macroscopic viewing.

5 Evaluation

The test was carried out on a parapet system made from perforated compact boards and a steel frame.

The parapet system meets the requirement regarding impact energy tested by soft body impact according ETB Guideline “Fall Prevention Components”, § 3.2.2.2.2.

The parapet system meets the requirement regarding hard body impact according ETB Guideline “Fall Prevention Components”, § 3.2.3.

Note that different results can be obtained in case of use of other supporting construction and other fasteners.

Dipl.-Ing. J. Gecks
Person in-charge