Report

Metacon Branddeuren
Attn. Mr. M. Asscheman
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THE NETHERLANDS

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Project number 2015129

Expert judgement on fire resistance
Maximum dimensions of Metacon EW90 / EW120 rolling shutter

Dear Mr. Asscheman,

You have requested Efectis Nederland BV to give expert judgement, using where possible the EXAP standard EN 15269-10:2011, on the fire resistance of a rolling shutter construction developed by your firm. The rolling shutter is of type Metacon EW90 / EW120.

The construction has been tested for fire resistance in two variations. The first fire test (performed with 1 mm steel thickness of the lamella's) is reported in TNO report 2003-CVB-R0123 dd. April 2003. A second fire test (performed with 0.8 mm steel thickness of the lamella's) is reported in Efectis NL report 2013-Efectis-R0536a[Rev. 1] dd. February 2014.

Your question is what the maximum dimensions of the rolling shutter can be if the rules from the EXAP standard EN 15269-10:2011 are followed. This will be explained in this letter.

This expert judgement is based on:

− TNO test report 2003-CVB-R0123 dd. April 2003;

− Efectis NL test report 2013-Efectis-R0536a[Rev. 1] dd. February 2014;

− Standards EN 1634-1:2014, EN 15269-10:2011;

− Knowledge and experience of Efectis Nederland BV.

TNO test report 2003-CVB-R0123

This report gives the results of two fire tests which were performed on a rolling shutter of type IBRL-147. The rolling shutter construction was mounted on the directly exposed side of a supporting construction of 150 mm aerated concrete. The aperture size was 3340 x 2650 mm (width x height).

The fire tests were performed on 21 March 2003 according to the Dutch standard NEN 6069:2001. See photo 1 for the test specimen, before the fire test. The results can be summarized as follows:

- Integrity (E)   150 minutes (end of fire test)
- Heat radiation (W)   147 minutes

Photo 1

Efectis NL test report 2013-Efectis-R0536a [Rev. 1]

This report gives the results of two fire tests which were performed on a rolling shutter of type Metacon RGS E120 ECO. The rolling shutter constructions were mounted in a supporting construction of 150 mm aerated concrete. The aperture size was 3340 x 2810 mm (width x height). The difference between the two fire tests was the side of the supporting construction on which the rolling shutter was mounted. One test was performed with the rolling shutter mounted on the fire side and the other one with the rolling shutter mounted on the non-fire side.

The fire tests were performed on 28 and 29 January 2014, according to the European standard EN 1634-1:2014. The results can be summarized as follows:

Rolling shutter mounted on	the fire side	the non-fire side
• Integrity (E)	133 minutes	135 minutes
• Heat radiation (W)	133 minutes	135 minutes

See photo 2 for the test specimen, mounted on the fire side, before the fire test.

Photo 2

1. EXPERT JUDGEMENT

You have asked what the maximum dimensions of the rolling shutter of type Metacon EW90 / EW120 are, in case the extrapolation rules in the EXAP standard EN 15269-10:2011 are followed.

The rolling shutter type Metacon EW90 / EW120 is a combination of the rolling shutters of type Metacon RGS E120 ECO and IBRL-147 as tested previously. The rolling shutter construction (barrel, side guides, end plates, etc.) is taken from the type RGS E120 ECO, where only the lamella's are taken from the type IBRL-147. This means a steel thickness of 1,0 mm, insulation with 20 mm thick Insulfrax, total thickness is 23 mm. The total height of the lamella's is 120 mm, with a working height of 100 mm.

In the EXAP standard EN 15269-10:2011 rules are given in articles A.1.2 and A.1.4 for the extrapolation of the height and width of tested constructions. These articles give specific requirements for E, EI and EW applications and refer to Annex B for methods of calculation.

These methods of calculation will, as far as possible, be followed in this document.
The calculations will be specific for the Metacon EW90 / EW120 rolling shutter construction.
The enlarged rolling shutter construction still has to fulfil the classification EW 90 and EW120.
The verification of the heat radiation of the rolling shutter at extended dimensions is given in Chapter 3.

B.3 Barrel calculations

For the rolling shutter configuration as tested, the following calculation applies.

Barrel outside diameter (D_B) =	133 mm
Lath length (L_L) =	3 600 mm
Height of shutter aperture (h_{AS}) =	2 810 mm
Weight per unit area of lath (ρ_L) =	22.5 kg/m^2
➔ Shutter weight (W_L) =	227 kg
Weight of barrel (W_B) =	43 kg
➔ Barrel assembly weight (W_{BA}) =	2646 N
Barrel wall thickness (t_B) =	3.0 mm
➔ Barrel moment of inertia (I_B) =	2 588 345 mm^4
➔ Barrel section modulus (Z_B) =	38 922 mm^3
Barrel length (L_B) =	3476 mm
➔ Barrel stress (σ_B) =	29.5 N/mm^2
Barrel deformation factor (E_B) =	7.1 10^3 N/mm^2, taken from EN 1993-1-2 for 1040 ^{o}C (= furnace temperature after 120 minutes heat exposure)
➔ Free deflection of barrel (d_B) =	78.7 mm

This maximum deformation of 78.7 mm in relation to a length of the barrel of 3476 mm corresponds to a deformation of 1/45 of the barrel length. This deformation can be accommodated in the labyrinth mounted on the wall and on the last lath. Also the overlap of the mounting frame of the rolling shutter has to be dimensioned for this. In the rest of this

document the maximum allowable deformation is set at 1/500 of the barrel length (when ≤ 10 meters) and at 1/800 of the barrel length (when > 10 meters).

If the maximum deformation of the barrel length is exceeded you will use a heavier type of barrel. First you will increase the wall thickness of the barrel within the possible thicknesses of 4.0 – 6.3 mm, eventually combined with an increase in the diameter of the barrel; within the possible diameters of 168.3 – 219.1 – 323.9 mm.

A summary table of acceptable dimensions is given in Table 1.

Table 1 – Summary of barrel dimensions in relation to the dimensions

Clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Barrel diameter [mm]	Wall thickness of the barrel [mm]
3 000 x 3 000	203	159.0	3.0
4 000 x 4 000	360	159.0	3.0
5 000 x 5 000	563	168.3	4.0
6 000 x 6 000	810	219.1	4.0
7 000 x 7 000	1 103	323.9	4.0
8 000 x 8 000	1 440	323.9	4.0
10 000 x 8 000	1 800	355.6	4.0
8 000 x 10 000	1 800	323.9	4.0
12 000 x 7 000	1 890	508.0	4.0
7 000 x 12 000	1 890	323.9	4.0
15 000 x 6 000	2 025	610.0	4.0
6 000 x 15 000	2 025	323.9	4.0

For the present calculation the maximum dimensions of the rolling shutter are set to 15 x 6 meters. The EXAP standard EN 15269-10:2011 does not mention maximum dimensions.

B.5   Axle calculations

Axle diameter (D_A) =   30 mm

➔   Axle section modulus (Z_A) =   2 651 mm^3

Motor weight (W_{AL}) =   6 kg

Axle length (L_A) =   20 mm (determining till support)

Lath length (L_L) =   4000 mm

Height of shutter aperture (h_{AS}) =   4000 mm

➔   Barrel assembly weight (W_{BA}) =   936 N

➔   Axle bending stress (σ_{A1}) =   8 N/mm^2

➔   Axle shear stress (σ_{A2}) =   1 N/mm^2

This values is under the allowed stresses because according to EN 1993-1-2 it is specified that 3% of the strength of the steel at room temperature will remain at a temperature of 1040 ^{0}C (this is taken as the temperature in the furnace after 120 minutes of heating). This means 3% of 355 N/mm^2 = 10.7 N/mm^2.

In case of larger dimensions and weights, the axle diameter will be increased. You indicated that because of larger dimensions or weights the axle diameter will be chosen from the range 30 – 40 – 50 – 60 – 80 – 100 – 120 mm. Efectis NL suggest to incorporate some safety margin, and thus advises to stay below 10 N/mm^2. Results are presented in Table 2.

Table 2 – Summary of axle diameters

Clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Axle diameter [mm]
3 000 x 3 000	203	30.0
4 000 x 4 000	360	40.0
5 000 x 5 000	563	50.0
6 000 x 6 000	810	60.0
7 000 x 7 000	1 103	60.0
8 000 x 8 000	1 440	80.0
10 000 x 8 000	1 800	100.0
8 000 x 10 000	1 800	80.0
12 000 x 7 000	1 890	100.0
7 000 x 12 000	1 890	80.0
15 000 x 6 000	2 025	100.0
6 000 x 15 000	2 025	80.0

B.6   Endplate calculations

In annex B.6 a method of calculation is given for the dimensioning of the end plates that support the barrel axle on both sides of the barrel.

Endplate height (h_E) =	350 mm
Fixing angle cross-sectional area (A_{FA}) =	350 x 3 = 1050 mm^2
➔ Weight of fixing angle (W_{EEL}) =	288.5 N
Endplate width (w_E) =	350 mm
Endplate thickness (t_E) =	3 mm
Endplate cross-sectional area (A_E) =	1050 mm^2
Area correction factor (ϕ) =	1.0 [-]
Length correction factor (φ) =	16.67 [-]

50% of barrel assembly weight (W_E) =	468 N
Axle end bearing length (L_E) =	10 mm
Load on end plate due to motor (W_M) =	60 N
Effective motor shaft length (L_M) =	300 mm
➜ Endplate bending stress (σ_{EB}) =	2.4 N/mm^2
Endplate self-weight (W_{ESL}) =	28,3 N
Eccentric loading (W_{EL}) =	528 N
Total endplate load (W_T) =	532 N
Number of bolts =	5
Cross-section of bolt (M10) =	75 mm^2
➜ Shear stress in bolts (τ_{EFB}) =	1.4 N/mm^2
➜ Tensile force on top bolt (F_{EFB}) =	122.5 N
➜ Tensile stress in top bolt (σ_{EFB}) =	1.6 N/mm^2

These values are under the allowed stresses because according to EN 1993-1-2 it is specified that 3% of the strength of the steel at room temperature will remain at a temperature of 1040 ^{0}C (this is taken as the temperature in the furnace after 120 minutes of heating). This means 3% of 355 N/mm^2 = 10.7 N/mm^2.

In case of larger dimensions and weights, the endplate cross-sections will be increased. The dimensions will be taken in the following steps : width and height 200 – 250 – 300 – 350 – 400 mm etc., and the thickness is chosen as 3 – 4 – 5 mm etc. Efectis NL suggest to incorporate some safety margin, and thus advises to stay below 10 N/mm^2. Results are presented in Table 3.

Table 3 – Summary of endplate dimensions

Clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Endplate height x width [mm]	Endplate thickness [mm]
3 000 x 3 000	203	350 x 350	3.0
4 000 x 4 000	360	400 x 400	3.0
5 000 x 5 000	563	450 x 450	3.0
6 000 x 6 000	810	500 x 500	4.0
7 000 x 7 000	1 103	600 x 600	6.0
8 000 x 8 000	1 440	600 x 600	8.0
10 000 x 8 000	1 800	650 x 650	10.0
8 000 x 10 000	1 800	650 x 650	8.0
12 000 x 7 000	1 890	700 x 700	12.0

7 000 x 12 000	1 890	700 x 700	10.0
15 000 x 6 000	2 025	750 x 750	12.0
6 000 x 15 000	2 025	750 x 750	10.0

B.7   Shutter expansion allowance

If the width of the rolling shutter in practice is larger than in the test, then the depth in through which the laths fall in the side guides will be increased by 5 mm per extra meter of width. If the rolling shutter is less wide then tested then the side guides will be constructed as tested.

B.8   Fire performance of fixings

In test report 2013-Efectis-R0536a[Rev. 1] it is proven that the tested fixing method (anchoring completely through the wall with anchor plates on the cold side) is a suitable method for a fire resistance of at least 120 minutes if the rolling shutter is mounted on an aerated concrete wall with a thickness of 150 mm. The rolling shutter may also be mounted on heavier supporting constructions such as concrete as long as the fixing method stays the same as tested and the wall is at least 150 mm thick.

For other types of supporting constructions or fixing methods it has to be proven that they fulfil the requirements given in the EXAP standard EN 15269-10 in the articles J.1.1 t/m J.1.6. The rolling shutter may also be mounted on a steel supporting construction if the requirements of article J.2.1 of EN 15269-10:2011 are fulfilled.

2.   VERIFICATION HEAT RADIATION AT EXTENDED DIMENSIONS

The heat radiation of the rolling shutter of type Metacon EW90 / EW120 is primarily due to the heat radiation from the lamella's. The lamella's are taken from the IBRL-147 type. From the test report 2003-CVB-R0123 the following heat radiation has been measured:

Time	Heat radiation
30 minutes	4 kW/m^2
60 minutes	8 kW/m^2
90 minutes	11 kW/m^2
120 minutes	13.5 kW/m^2

These values are measured from the rolling shutter with aperture dimensions 3340 x 2650 mm (width x height), see Photo 1.

In the Extended Application EN 15269-10 reference is made to Annex B of EN 15254-4:2008 for a heat radiation calculation for the extended sizes. Following the formulae given in Annex B of EN 15254-4:2008 yields the results as presented in Table 4 (for EW90 application) and Table 5 (for EW120 application).

Table 4 – Summary of heat radiation calculations (EW90)

Clear opening dimensions w x h [mm]	Calculated heat radiation [kW/m^2] after 90 minutes heat exposure
3 000 x 3 000	11.1
4 000 x 4 000	12.6
5 000 x 5 000	13.4
6 000 x 6 000	13.9
7 000 x 7 000	14.2
8 000 x 8 000	14.4
10 000 x 8 000 or 8 000 x 10 000	14.5
12 000 x 7 000 or 7 000 x 12 000	14.5
15 000 x 6 000 or 6 000 x 15 000	14.5

Table 5 – Summary of heat radiation calculations (EW120)

Clear opening dimensions w x h [mm]	Calculated heat radiation [kW/m^2] after 120 minutes heat exposure
2 750 x 15 000 or 15 000 x 2 750	14.3
3 000 x 6 000 or 6 000 x 3 000	14.9
3 250 x 5 500 or 5 500 x 3 250	15.0
3 500 x 4 500 or 4 500 x 3 500	14.9
3 750 x 3 750	14.9
4 000 x 4 000	> 15.0

3. CONCLUSION

All parts of the construction have been evaluated using the EXAP standard EN 15269-10.

Based on this approach it is concluded that the rolling shutter construction type Metacon EW90 / EW120, as tested and described in Efectis NL test report 2013-Efectis-R0536a[Rev. 1], with the lamella's taken from TNO test report 2003-CVB-R0123, will have a fire resistance of 90 minutes based on the criterion *integrity* and *heat radiation* (EW90).

The construction may be enlarged under the following conditions:

- Maximum dimensions are 15 x 6 meter (width x height or height x width)

- Dimensioning of the barrel dimensions according to Table 1 in B.3

- The axle dimensions at the end plates will be dimensioned on the basis that the remaining steel strength will be at least 3% of the strength at room temperature, see B.5 and B.6

- Modification of the side guides according to B.7

- Mounting of the rolling shutter construction following the guide lines from B.8

Yours sincerely,

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