Report

Metacon B.V.
Attn. Mr. V. Vergunst
James Wattstraat 14
2809 PA GOUDA

Our reference   2013-Efectis-R0103.211b/BGG/TNL   Bleiswijk, 28 March 2014
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Expert judgement on fire resistance
Maximum dimensions of Metacon RGS E60 rolling shutter

Dear Mr. Vergunst,

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 RGS E60.

The construction has been tested for fire resistance. The test results are described in Efectis NL report 2013-Efectis-R0421a dd. October 2013. The tested dimensions of the rolling shutter were 3415 x 3300 x 1.0 mm (width x height x thickness). In the direct field of application in the test report an extension of the tested dimensions is not allowed.

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:

− Efectis NL test report 2013-Efectis-R0421a dd. October 2013;

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

− Knowledge and experience of Efectis Nederland BV.

Efectis NL test report 2013-Efectis-R0421a

This report gives the results of a fire test which was performed on a rolling shutter of type Metacon RGS E60. The rolling shutter construction had overall dimensions 3415 x 3300 x 1.0 mm (width x height x thickness). For the fire test, the rolling shutter was mounted on the directly exposed side of the supporting construction (i.e. 150 mm thick aerated concrete).

The fire test was performed on the 30th September 2013, according to the European standard EN 1634-1:2008. The results can be summarised as follows:

- Integrity (E)   no failure during 68 minutes heat exposure

- Heat radiation (W)   21 minutes

See photo 1 for the test specimen, 5 minutes after the start of the fire test.

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Photo 1

Expert judgement

You have asked what the maximum dimensions of the rolling shutter are if the extrapolation rules in the EXAP standard EN 15269-10:2011 are followed.

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 RGS E60 construction. The rolling shutter construction has to remain fulfilling the classifications E 60.

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) =	3 415 mm
Height of shutter aperture (h_{AS}) =	2 870 mm
Weight per unit area of lath (ρ_L) =	12.6 kg/m^2
➜ Shutter weight (W_L) =	138 kg
Weight of barrel (W_B) =	43 kg
➜ Barrel assembly weight (W_{BA}) =	1 776 N
Barrel wall thickness (t_B) =	3 mm
➜ Barrel moment of inertia (I_B) =	2 588 345 mm^4

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➔   Barrel section modulus (Z_B) =   38 922 mm^3

Barrel length (L_B) =   3 475 mm

➔   Barrel stress (σ_B) =   19.82 N/mm^2

Barrel deformation factor (E_B) =   63 10^3 N/mm^2, taken from EN 1993-1-2
for 950 degC (= furnace temperature after 60 minutes heat exposure)

➔ Free deflection of barrel (d_B) =   5.95 mm

This means a maximum deformation of 5.95 mm in relation to a length of the barrel of 3475 mm. This corresponds to a deformation of 1/600 of the length of the barrel. 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.

If the maximum deformation of 1/500 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 of the rolling shutter

clear opening dimensions [mm]	Weight of the rolling shutter [kg]	Barrel diameter [mm]	wall thickness of the barrel [mm]
3 000 x 3 000	114	133.0	3.0
4 000 x 4 000	202	133.0	3.0
5 000 x 5 000	315	159.0	3.0
6 000 x 6 000	454	168.3	4.0
7 000 x 7 000	618	219.1	4.0
8 000 x 8 000	807	219.1	6.3
10 000 x 8 000	1 008	323.9	4.0
8 000 x 10 000	1 008	273.0	4.0
12 000 x 7 000	1 058	406.4	5.0
7 000 x 12 000	1 058	244.5	4.0
15 000 x 6 000	1 134	508.0	6.3
6 000 x 15 000	1 134	219.1	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.

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B.5 Axle calculations

Axle diameter (DA) =		30 mm
➜	Axle section modulus (ZA) =	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 10% of the strength of the steel at room temperature will remain at a temperature of 950 ^{0}C (this is taken as the temperature in the furnace after 60 minutes of heating). This means 10% of 355 N/mm^2 = 35.5 N/mm^2.

In case of larger dimensions and weights, the axle diameter will be increased, see Table 1. The diameter will be chosen such that the combined stress will stay below 35.5 N/mm^2. Efectis NL suggest to incorporate some safety margin, and thus advises to stay below 15 N/mm^2.

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

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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 10% of the strength of the steel at room temperature will remain at a temperature of 950 ^{0}C (this is taken as the temperature in the furnace after 60 minutes of heating). This means 10% of 355 N/mm^2 = 35.5 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 15 N/mm^2.

B.7   Curtain 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-R0421a 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 68 minutes (E characteristic only) 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.

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 RGS E60, as tested and described in Efectis NL test report 2013-Efectis-R0421a, will have a fire resistance of 60 minutes based on the criterion integrity (E60).

The construction may be enlarged under the following conditions:

- 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 5% of the strength at room temperature, see B.5 and B.6

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- 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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