

ROCKWOOL® FIRESAFE INSULATION

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**Airtightness of BLOWERPROOF® LIQUID and ISOPROOF FR on concrete block walls with ROCKWOOL® ROCKSATE DUO PLUS insulation panels: impact of different insulation support anchors**

HEVADEX BVBA commissioned Ghent University to measure the impact of the installation of different insulation support anchors on the airtightness of a single wythe concrete block wall with a liquid applied airtightness coating.

Following wall configurations were evaluated on a concrete block wall:

Coating	Hevadex Blowerproof Liquid		Hevadex Isoproof FR	
Insulation	Rockwool Rocksate Duo Plus		Rockwool Rocksate Duo Plus	
Mortar	No	Yes	No	Yes
No anchors	X	X	X	X
Ejot DH anchors	X		X	
Rawlplug R-TFIX-8S anchors	X	X	X	X
Ejot H2 anchors		X		X
Ejotherm STR U 2G		X		X

The airtightness was tested in the Test Centre for Facade Elements, part of Ghent University. The tests are performed in a full-scale test setup built in a steel box, according to EN 12114:2000 "Thermal performance of buildings - Air permeability of building components and building elements - Laboratory test method".



Figure 1: Laboratory Test Device; Lindab LT 600

## 1. Test setup and procedure

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### 1.1. Procedure

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The airtightness is measured following the guidelines described in the norm EN 12114:2000 "Thermal performance of buildings - Air permeability of building components and building elements - Laboratory test method". The test is performed on a calibrated test rig, and the laboratory follows all requirements set by EN ISO 17025:2005. All sensors meet the requirements set by EN 12114:2000.

The tests were carried out within the constraints imposed by EN 12114:2000:

- Temperature within the interval [15 °C, 30 °C]
- Relative humidity within the interval [25%, 75%]

The measured air leakage  $Q_{tot}$  consists of three different components:

$$Q_{tot} = Q_{testrig} + Q_{wall} + Q_{anchors} \quad [m^3/h]$$

The flow  $Q_{testrig}$  is the air leakage through the entire test rig, between the tested wall and the flow meter placed after the ventilator.  $Q_{wall}$  is the air leakage through the concrete block wall with liquid applied cover,  $Q_{anchors}$  is the additional leakage due to the installation of the anchors.

It is assumed that the airflow through the test rig is negligible, and hence is included in the air leakage rate of  $Q_{wall}$ . In the sequence the leakage through the wall is tested first, and only afterwards anchors are installed. By subtracting  $Q_{wall}$  from  $Q_{tot}$  the leakage due to the anchors  $Q_{anchors}$  is quantified. If  $Q_{testrig}$  is not equal to zero, it will hence lead to an overestimation of  $Q_{wall}$ , but will have no impact on  $Q_{anchors}$ .

Based on a t-distribution on 40 measurements, it was concluded that a 95% confidence interval of the air leakage results in a 3,965% error.

### 1.2. Reference conditions

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The measured air leakage is corrected for standard conditions (20 °C, 50% relative humidity, 101325 Pa) as follows:

$$\dot{V}_0 = \dot{V} * \sqrt{\frac{p_a - 0.378802 * 610.5 * RH * \exp^{\frac{21.875 * (T - 273.15)}{T - 7.65}}}{287.055 * T * \rho_0}}$$

Where:

$\dot{V}_0$	= corrected air flow rate at reference conditions	[m <sup>3</sup> /h]
$\dot{V}$	= measured air flow rate at laboratory conditions	[m <sup>3</sup> /h],
$\rho_0$	= density of the air at reference conditions ( $\rho_0 = 1,1988 \text{ kg/m}^3$ )	[kg/m <sup>3</sup> ]
$p_a$	= atmospheric pressure	[Pa]
$T$	= absolute temperature	[K]
$RH$	= relative humidity	[%]

The maximum error of the measurement instruments is respectively 20 Pa, 0,5 K and 2% RH. Monte-Carlo analysis on 1000 simulations shows the maximum impact of this measurement error is limited to 0,14% on the overall result, which can be considered negligible.

### 1.3. Setup

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Two single wythe walls of 9cm thickness were constructed in steel frames using solid concrete blocks. The walls are 1070mm wide and 2390mm high, which yields a surface area of 2.557m<sup>2</sup>.

One wall was then treated with BLOWERPROOF® LIQUID, whereas the second wall was treated with ISOPROOF FR. Both products were applied with an airless spray machine, and the application thickness was around 700g/m<sup>2</sup> (within specifications of the manufacturer; 500 – 800g/m<sup>2</sup>).



Figures 2: Airless application of BLOWERPROOF® LIQUID (left) and ISOPROOF FR (right)

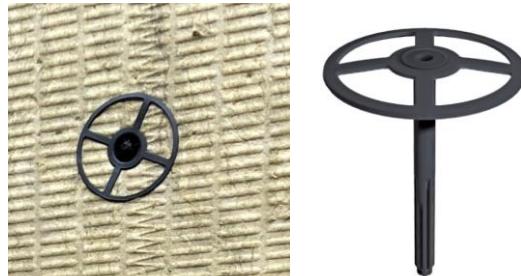


Figures 3: Walls covered with BLOWERPROOF® LIQUID (left) and ISOPROOF FR (right)

The coatings were left to dry at least one week before the first airtightness test was conducted. Subsequently, ROCKWOOL® ROCKSATE DUO PLUS panels of 80mm were installed. The panels were not fixed to the wall by means of glue or mortar, only using insulation anchors. For each combination tests were conducted with 1, 2, 3, 4 and 6 anchors, but the results in this report are based on the tests with 6 anchors as this allows to level out minor variations between individual anchors. All anchors except Ejot DH have a length of 135mm and were installed in level with the surface of the insulation, which implies that the anchors are fixed 55mm into the wall. The Ejot DH anchors are installed 30-40mm into the wall. All anchors have a diameter of 8mm, and holes were drilled with an 8mm drill.

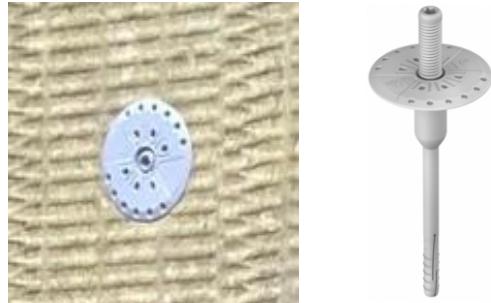
Following anchors were used:

- Ejot DH anchors



Figures 4: Test setup (left), Type (right)

- Rawlplug® R-TFIX-8S anchors



Figures 5: Test setup (left), Type (right)



Figures 6:

Left: drilling machine with 8mm drill

Middle: wall with BLOWERPROOF® LIQUID with 12 anchors (6 grey Rawlplug® and 6 black Ejot DH)

Right: wall with ISOPROOF FR with 12 anchors (6 grey Rawlplug® and 6 black Ejot DH)

In the subsequent step, all anchors were removed and the holes were covered with BLOWERPROOF® LIQUID and ISOPROOF FR in the corresponding walls. PRIMER 52 was applied to make the coatings rougher so that the mortar could adhere better. Again the ROCKWOOL® ROCKSATE DUO PLUS panels of 80mm were installed, but now the panels were fixed to the walls by means of a 1cm mortar layer of ROCKWOOL® REDArt™ CAPA BASE CASA. Tests were conducted for each type of anchor with 1, 2, 3, 4, and 6 anchors, whereas only the latter is used in this report. Again, anchors have a diameter of 8mm and length of 135mm. However, due to the mortar layer the anchors are now fixed 45mm into the wall.



Figure 7: PRIMER 52 was applied with brush



Figure 8: Insulation panel covered with mortar REDArt™ CAPA BASE CASA



Figure 9: Insulation panel placed on the walls



Figure 10: both walls ready for testing

Following anchors were used:

- Rawlplug® R-TFIX-8S anchors



Figure 11: Test setup (left), Type (right)

- Ejot H2 anchors



Figure 12: Test setup (left), Type (right)

- Ejotherm STR U 2G



Figure 13: Test setup (left), Type (right)



Figures 14: Concrete walls with BLOWERPROOF® LIQUID (left) and ISOPROOF FR (right), PRIMER 52, REDArt™ CAPA BASE CASA, ROCKWOOL® ROCKSATE DUO PLUS and 15 anchors (6 green Ejot H2, 6 white Ejot STR U 2G, 3 grey Rawlplug®)

## 2. Measurement results

For every measurement and reference measurement, the air leakage is measured for a range of pressure differences in the interval [0 Pa – 600 Pa] in line with EN 12114. A statistical analysis checks the results for outliers and deletes them if present. Flow coefficient and flow exponent are calculated which describe an exponential function. This function is consequently used to calculate the air leakage for the pressure differences 50 – 100 – 150 – ... – 600 Pa, which allows to compare different measurements.

Table 1 provides an overview of the results at 50Pa pressure difference, whereas table 2 reports the results at 600Pa pressure difference. The result for 'No anchors' refers to the original situation of the coating without any penetrations. It should be noted that first tests were done without mortar, and the test with mortar thus includes a total of 12 reparations in the wall, of which the effect becomes visible at higher pressure differences. In general, it can be concluded that there are little specific trends to differentiate between the different anchor systems. The BLOWERPROOF® LIQUID shows a smaller air leakage rate compared to the ISOPROOF FR, but the impact of the anchors is slightly larger. At 50Pa the effect of the anchors is very limited, and ranges between 0.000 and 0.003m<sup>3</sup>/h per anchor. At 600Pa the effect of the anchors ranges between 0.000 and 0.021m<sup>3</sup>/h per anchor.

*Table 1. Air leakage rate at 50Pa [m<sup>3</sup>/h.m<sup>2</sup>] of the original coating, and the additional effect of the installation of 1 anchor*

Coating	Hevadex Blowerproof Liquid		Hevadex Isoproof FR	
Insulation	Rockwool Rockstate Duo Plus		Rockwool Rockstate Duo Plus	
Mortar	No	Yes	No	Yes
No anchors	<b>0,019</b>	<b>0,013</b>	<b>0,067</b>	<b>0,029</b>
Ejot DH anchors	<i>+0,001</i>		<i>+0,001</i>	
Rawlplug R-TFIX-8S anchors	<i>+0,001</i>	<i>+0,000</i>	<i>+0,001</i>	<i>+0,000</i>
Ejot H2 anchors		<i>+0,003</i>		<i>+0,000</i>
Ejotherm STR U 2G		<i>+0,001</i>		<i>+0,000</i>

*Table 2. Air leakage rate at 600Pa [m<sup>3</sup>/h.m<sup>2</sup>] of the original coating, and the additional effect of the installation of 1 anchor*

Coating	Hevadex Blowerproof Liquid		Hevadex Isoproof FR	
Insulation	Rockwool Rockstate Duo Plus		Rockwool Rockstate Duo Plus	
Mortar	No	Yes	No	Yes
No anchors	<b>0,120</b>	<b>0,430</b>	<b>0,090</b>	<b>0,227</b>
Ejot DH anchors	<i>+0,021</i>		<i>+0,002</i>	
Rawlplug R-TFIX-8S anchors	<i>+0,013</i>	<i>+0,000</i>	<i>+0,006</i>	<i>+0,000</i>
Ejot H2 anchors		<i>+0,015</i>		<i>+0,000</i>
Ejotherm STR U 2G		<i>+0,007</i>		<i>+0,001</i>

### 3. Conclusions

Two 9cm concrete block walls were treated with hevadex coatings and the airtightness was tested according to NBN EN 12114:2000.

- Hevadex BLOWERPROOF® LIQUID : 0.019 m<sup>3</sup>/h.m<sup>2</sup> @ 50Pa
- Hevadex ISOPROOF FR: 0.067 m<sup>3</sup>/h.m<sup>2</sup> @ 50Pa

*Table 3. Air leakage results at 50Pa [m<sup>3</sup>/h.m<sup>2</sup>] of BLOWERPROOF® LIQUID, and the additional effect of the installation of 1-8 anchors per m<sup>2</sup>*

Coating	BLOWERPROOF® LIQUID				
Insulation	ROCKWOOL® ROCKSATE DUO PLUS				
Mortar	REDArt™ CAPA BASE CASA				
Mortar	NO		YES		CLASS
No anchors	0,019		0,013		ph A
	1 anchor	6 / 8 anchors/m <sup>2</sup>	1 anchor	6 / 8 anchors/m <sup>2</sup>	
Ejot DH	+0,001	0,025 / 0,027			ph A
Rawlplug® R-TFIX-8S	+0,001	0,025 / 0,027	+0,000	0,013	ph A
Ejot H2			+0,003	0,031 / 0,037	ph A
Ejotherm STR U 2G			+0,001	0,019 / 0,021	ph A

*Table 4. Air leakage results at 50Pa [m<sup>3</sup>/h.m<sup>2</sup>] of ISOPROOF FR, and the additional effect of the installation of 1-8 anchors per m<sup>2</sup>*

Coating	ISOPROOF FR				
Insulation	ROCKWOOL® ROCKSATE DUO PLUS				
Mortar	REDArt™ CAPA BASE CASA				
Mortar	NO		YES		CLASS
No anchors	0,067		0,029		ph A
	1 anchor	6 / 8 anchors/m <sup>2</sup>	1 anchor	6 / 8 anchors/m <sup>2</sup>	
Ejot DH	+0,001	0,073 - 0,075			ph A
Rawlplug® R-TFIX-8S	+0,001	0,073 - 0,075	+0,000	0,029	ph A
Ejot H2			+0,000	0,029	ph A
Ejotherm STR U 2G			+0,000	0,029	ph A

The effect of different insulation anchors was measured on both coatings, installed on a 80mm ROCKWOOL® ROCKSATE DUO PLUS, with and without the ROCKWOOL® REDArt™ CAPA BASE CASA mortar.

The additional air loss due to the anchors ranges between 0.000 and 0.003 m<sup>3</sup>/h per anchor at 50Pa. The differences between anchor types can rather be attributed to inherent variability than systematic differences. The absolute impact at 50Pa for 5 anchors is limited to 0.015m<sup>3</sup>/h.m<sup>2</sup>. Even though this causes in some cases a doubling of the leakage rate, this is due to the very reference leakage rate.

The mortar of the insulation panel reduces the air leakage rate through the reference wall, and as well, reduces the impact of the anchors.

*Table 5. Air leakage criteria at 50Pa [m<sup>3</sup>/h.m<sup>2</sup>] according to the Passive House Institute Germany (EN 12114:2000)*

Passive House Institute Criteria	
Class	Air Permeability per unit area @ 50 Pa {m <sup>3</sup> /(hm <sup>2</sup> )}
ph A	< 0,10
ph B	< 0,18
ph C	< 0,25

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