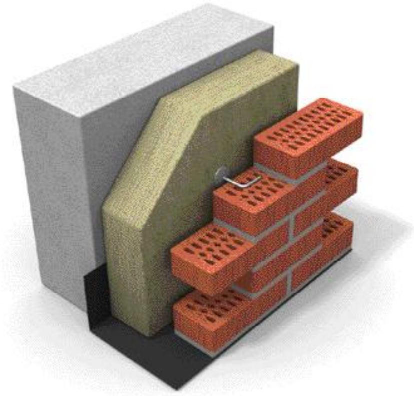
Ventilated Walls

Design Principles



Background

National building codes seldom give any requirements for wind protection. In such cases our recommendations below could be followed. If requirements are given in national building codes, and exceed these recommendations, the national requirements should be followed.

The recommendations below are based on scientific investigations, carried out in Finland and Lithuania by external research institutes, and long-term experience in the Nordic countries.

Ventilated façades can be designed in many different ways, but all systems should prevent deterioration of the inner shell due to moisture. If the thermal insulation has an open structure, like universal slabs, this needs to be shielded by a wind barrier so that the thermal performance of the insulation is preserved. The air ventilation openings in the facade layer, and the gap thickness, determine the wind protection needed.

The construction examples shown below create a foundation for a durable and functioning building.

Air infiltration through the structure

To avoid air flowing through the structure and causing negative effects, an air infiltration barrier needs to be placed on the inside of the building envelope. The requirements of air tightness set for the barrier are often given in the building codes for each market area, but the general trend is towards improved air tightness, in particular after the adoption of the Energy Performance Directive in Europe.

In practice, sufficient air tightness is achieved by the use of massive structures such as concrete or masonry, but in the case of (light) frame constructions, an air infiltration barrier such as a plastic foil is necessary. The air tightness of the building envelope could be measured in accordance with the standardized pressure test EN 13829, by subjecting the building to a 50 Pa overpressure and evaluating the air exchange rate of the building. The air exchange rate should not exceed 1 per hour.

Cold air intrusion

In a ventilated exterior wall, an air gap is placed behind the facade. The purpose of the gap is to remove excess moisture from the structure by the flow of air, and keep it dry to ensure proper functioning. The air flow in the gap is normally upwards. Openings are designed at the bottom to allow the air to enter the gap. In the gap the air warms, picking up moisture, and flows up until released through the openings at the top of the wall.

A wind barrier is used to stop the wind from blowing through or around the universal (light density) thermal insulation and causing “forced” convection in the insulation. This would have a negative impact on the thermal performance of the universal insulation.

The wind protection should also have relevant moisture vapor transfer capability in order to transfer moisture vapor into the ventilated air gap. The surface material of the wind protection should also be chosen to comply with the fire safety requirements in each market area. The fire safety requirements are usually only imposed for high-rise buildings. The wind protection can either be a faced or non faced stone wool board or slab, structural board, or a foil. Corners are often a critical point in ventilated wall constructions so special care must be taken in order to avoid air intrusion. See examples of solutions in the installation guidelines.

Air flow resistance

Definitions with an example, PAROC WAS 25, 30 mm

Air permeability or l - value (m^3/Pa m s 10^{-6}) is a material property independent of thickness. The numerical value in the product names for PAROC WAS and WAB products indicates the air permeability.

For example PAROC WAS 25 has an l - value of 25 x 10^{-6} m^3/Pa m s, measured according to the European standard EN 29053.

Air flow resistivity r (Pa s m/m^3, or usually given as kPa s/m^2) is the inverted l – value. This is also a material property independent of product thickness.

The air flow resistivity of PAROC WAS 25 is

$1/25 \times 10^{-6}$ m^3/Pa m s = 40 000 Pa m s/m^3 = 40 kPa s/m^2

Specific airflow resistance Rs (usually given in kPa m s/m^2) is the air flow resistance of a slab with a thickness d and is the resistivity times the thickness. This value is used during dimensioning of the wind protection. The examples describe how it is used.

The specific air flow resistance of PAROC WAS 25 is

Rs = r x d = 40 kPa s/m^2 x 0,03 m = 1,2 kPa m s/m^2)

For wind protection or products with a wind protection facing, the specific airflow resistance can be given directly (see table 3 Tyvek – faced WPS products)

The principles of ventilated wall design

The required specific air flow resistance of the layer against the ventilation depends on how fast the air flows in the ventilation layer, and how high the air permeability of the underlying insulation is. A wall can be designed without ventilation, with poor ventilation or with more or less high ventilation. The degree of ventilation is controlled by the ventilation openings in the façade. Table 1 shows different types of wall insulation systems based on the size of the air-vents. Av is the ventilation opening area in the bottom of the wall per meter.

Table 1. Examples of walls with different ventilation openings.

Ventilation	Size of ventilation, Av (cm^2/m)	Construction
Non or poorly ventilated	Av ≤ 5	Exterior walls without ventilation or walls with sheet materials with sealed/tightened joints such as rendered cement fiber sheets, slabs of concrete or glass facades. Slabs of concrete and cement fiber sheets.
Air ventilated	5 ≤ Av ≤ 300	Exterior walls as above with low degree of ventilation. Most walls are placed here. Nordic walls.
Intensively ventilated	300 < Av £400	Curtain wall with ventilation openings =400 cm^2/m
Very intensively ventilated	Av > 400	Curtain wall with ventilation openings >400 cm^2/m with multiple openings.

Table 2. Stone wool slabs for ventilated walls used for wind protection

Main wall insulation air resistivity ->	r < 5,2 (kPa xsx m/m^3)	5,2 ≤ r < 17 (kPa xsxm/m^3)	r ≥ 17 (kPa xsx m/m^3)
Wall ventilation (cm^2/m)	Recommended minimum air resistance (m kPa s m/ m^3) Of wind protection material and recommended choice of products to use		
Av<300	Rs > 1,2	Rs > 0,85	Stone wool slabs for thermal insulation can be used without a wind-protection layer. These slabs must be fixed mechanically or glued to the other partition layers, in order to eliminate air gaps between the slabs, as well as between the other layers of the partition.
300 < Av ≤ 400	*Rs > 1,2**		
400 < Av ≤ 1000	*Rs > 28,6**		

Table 2 shows Paroc recommended minimum values. If national building codes give requirements for wind protection, these should be followed. In other cases, our recommendations could be used.

Note *) These slabs must be fixed mechanically to the other partition layers in order to eliminate air gaps between the slabs as well as between the other layers of the partition.

Table 3. Specific air flow resistance Rs of Paroc products

PAROC:	WPS 1n WPS 3n	WAB 5t	WAB 10t	WAS 25	WAS 35	WAS 50
Air flow resistivity		200	100	40	29	20
Tyvek	100					
13 mm		2,6				
20 mm			2,0			
30 mm				1,2	0,9	
40 mm				1,6	1,2	0,8
50 mm				2,0	1,5	1,0
70 mm				2,8	2,0	1,4
80 mm				3,2	2,3	1,6
100 mm					2,9	2,0
150 mm						3,0

Recommendations and way of working

The methodology below only applies to dimensioning the wind protection layer if you are using Paroc stone wool products as a wind protection layer.

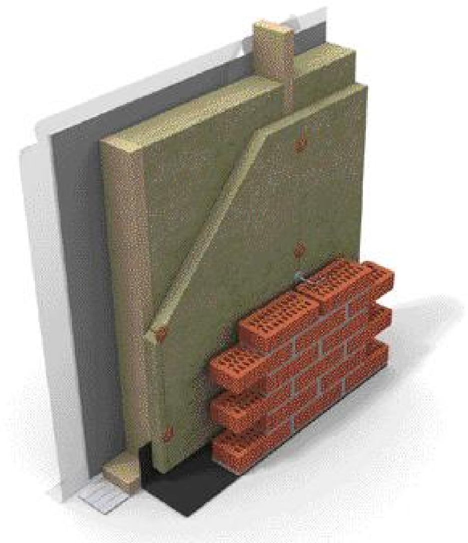
- Start from the wall construction and find the relevant ventilation level in *table 1*. If necessary measure or calculate the ventilation opening Av. Place the construction in the correct row in *table 2*.
- Check the U-value requirement and choose a suitable insulation product with a suitable thickness.
- Decide if you want a double layer system with different air resistances and if the wind barrier can be part of the thermal insulation.
- Check the air flow resistivity r of the main insulation and place the construction in the right column in *table 2*.
- Check if an additional wind protection layer is needed.

Note: Products with an air flow resistivity lower than 17 kPa s/m^2, for example PAROC UNS 37 should always be protected with a product with a sufficiently high air flow resistance.

Examples

Nordic Wall with Brick Lining

To ensure proper ventilation of the structure, every second or third vertical seam of the second lowest layer of bricks should be left open. The size of the ventilation opening area, Av is in this example;

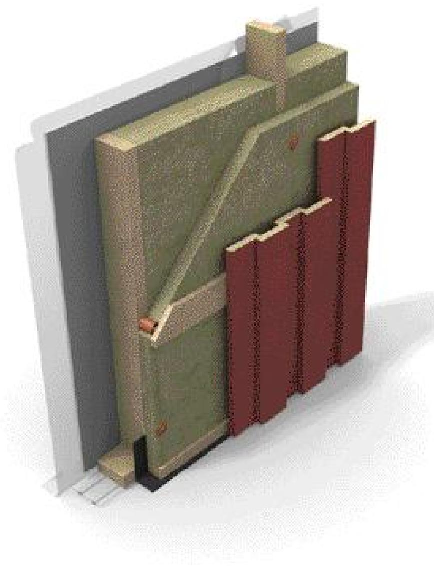


- Internal facing
- Air and vapor barrier
- Wooden stud and PAROC UNS 37 as main insulation
- Minimum PAROC WAS 25 ≥ 30mm or Minimum PAROC WAS 35 ≥ 30mm or Minimum PAROC WAS 50 ≥ 50mm
- Ventilation gap ≥ 20mm
- Bricks

Nordic Wall with Cladding

A cladding often allows higher air movement in the ventilation gap. Therefore we recommend the use of low air permeability products, such as PAROC WAS25 or WAS35 on top of the studs. The size of the ventilation opening area, Av is in this example.

Av=8 cm x 2,2 cm x 5 openings per meter = <u>88 cm2/m</u>



- Internal facing
- Air and vapor barrier
- Wooden stud and PAROC UNS 37 as main insulation
- Minimum PAROC WAS 25 ^{3} 30mm or Minimum PAROC WAS 35 ^{3} 30mm or Minimum PAROC WAS 50 ^{3} 50mm
- Nail batten + ventilation gap ^{3} 20mm
- Wooden panel

More application solutions can be found in the brochure "*Well insulated ventilated facades*".

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