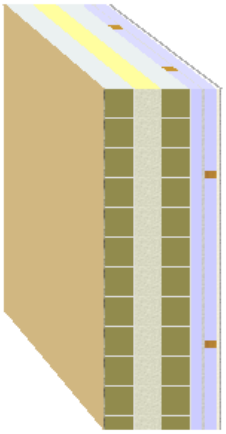
Documentation of the component 8. December 2022
Thermal transmittance (U-value) according to BS EN ISO 6946 Page 1/8

Source: **Airgreen 1**

Component: **New external wall**

OUTSIDE INSIDE



This illustration of inhomogeneous layers is provided only to assist in visualising the arrangement.

On the basis of the given information about the inhomogeneous layers, it is not possible to estimate how and where bearing elements intersect each other. It was assumed that the layers intersect crosswise. The size of the areas was calculated corresponding to their percentage of the whole area.

Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	BS EN 12524	Render, cement and sand	0.0100	1.000	D	0.0100
☑	2	Generic Building Materials	Concrete block (dense) outer leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.210	D	0.0826
☑	3	Xtratherm Limited	XtroLiner XO/RS Rainscreen	0.0900	0.021	C	4.2857
		Fixings	Vertical Twist galvanised steel No./m²:	2.5/m²	50.000	D	-
		Fixings	equivalent diameter: 0.0101 m / alpha: 0.800				
		Air gaps	Level 1: dU" = 0.01 W/(m²K)				
☑	4	Generic Building Materials	Concrete block (dense) inner leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.130	D	0.0885
☑	5	Inhomogeneous material layer	consisting of:	0.0350	ø 0.046		0.7689
	5a	kdb insulation	Low E airspace	88.00 %	0.034	E	-
	5b	BS EN 12524	Softwood Timber [500 kg/m³]	12.00 %	0.130	D	-
☑	6	KdB Ireland	Air-Reflect	0.0120	0.031	E	0.3871
☑	7	Inhomogeneous material layer	consisting of:	0.0400	ø 0.038		1.0571
	7a	kdb insulation	Low E airspace	96.00 %	0.034	E	-
	7b	BS EN 12524	Softwood Timber [500 kg/m³]	04.00 %	0.130	D	-
☑	8	British Gypsum Limited	Gyproc HandiBoard	0.0125	0.190	D	0.0658
☑	9	BS EN 12524	Gypsum plastering	0.0030	0.570	D	0.0053
		Rsi					0.1300
				0.4025			

Source: **Airgreen 1**
Component: **New external wall**

$R_T = (R_T' + R_T'')/2 = 7.04$ m²K/W

Correction to U-value for	according to	delta U [W/(m²K)]
Mechanical fasteners	BS EN ISO 6946 Annex F	0.0542
Air gaps	BS EN ISO 6946 Annex F	0.0037
		0.0579

$U = 1/R_T + \Sigma\Delta U = 0.20$ W/(m²K)

O .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
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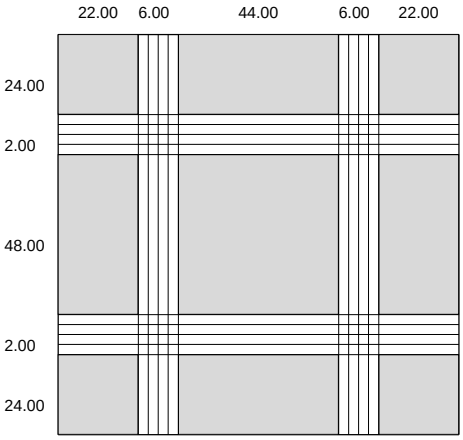
U = 0.20 W/(m²K) R_T= 7.04 m²K/W

Source: **Airgreen 1**
Component: **New external wall**

Draft of the component (portion in %):



The intersection of the inhomogeneous layers results in 4 Zones (A, B, C, D). Information given in %.

A	5.28 + 10.56 + 5.28 + 10.56 + 21.12 + 10.56 + 5.28 + 10.56 + 5.28 consisting of material layers: 1, 2, 3, 4, 5a, 6, 7a, 8, 9	= 84.48%
B	1.44 + 2.88 + 1.44 + 1.44 + 2.88 + 1.44 consisting of material layers: 1, 2, 3, 4, 5b, 6, 7a, 8, 9	= 11.52%
C	0.44 + 0.88 + 0.44 + 0.44 + 0.88 + 0.44 consisting of material layers: 1, 2, 3, 4, 5a, 6, 7b, 8, 9	= 3.52%
D	0.12 + 0.12 + 0.12 + 0.12 consisting of material layers: 1, 2, 3, 4, 5b, 6, 7b, 8, 9	= 0.48%

Upper limit of the thermal transfer resistance R

$$U_A\ [W/(m^2K)] = \frac{1}{(\sum R_{i,A}) + R_{si} + R_{se}} = \frac{1}{7.13 + 0.13 + 0.04} = 0.14$$

$$U_B\ [W/(m^2K)] = \frac{1}{(\sum R_{i,B}) + R_{si} + R_{se}} = \frac{1}{6.37 + 0.13 + 0.04} = 0.15$$

$$U_C\ [W/(m^2K)] = \frac{1}{(\sum R_{i,C}) + R_{si} + R_{se}} = \frac{1}{6.26 + 0.13 + 0.04} = 0.16$$

$$U_D\ [W/(m^2K)] = \frac{1}{(\sum R_{i,D}) + R_{si} + R_{se}} = \frac{1}{5.50 + 0.13 + 0.04} = 0.18$$

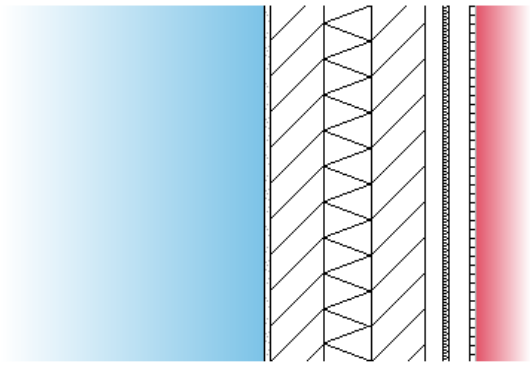
$$R_T' = \frac{1}{A * U_A + B * U_B + C * U_C + D * U_D} = 7.16\ m^2K/W$$

Lower limit of the thermal transfer resistance R

R_{se} [m²K/W]		= 0.04
R_1'' [m²K/W] = d_1/λ_1 =	0.0100 / 1.000	= 0.01
R_2'' [m²K/W] = d_2/λ_2 =	0.1000 / 1.210	= 0.08
R_3'' [m²K/W] = d_3/λ_3 =	0.0900 / 0.021	= 4.29
R_4'' [m²K/W] = d_4/λ_4 =	0.1000 / 1.130	= 0.09
R_5'' [m²K/W] = $d_5/(\lambda_{5a} * (A + C) + \lambda_{5b} * (B + D))$ =	0.0350 /(0.034 * 88.00% + 0.130 * 12.00%)	= 0.77
R_6'' [m²K/W] = d_6/λ_6 =	0.0120 / 0.031	= 0.39
R_7'' [m²K/W] = $d_7/(\lambda_{7a} * (A + B) + \lambda_{7b} * (C + D))$ =	0.0400 /(0.034 * 96.00% + 0.130 * 4.00%)	= 1.06
R_8'' [m²K/W] = d_8/λ_8 =	0.0125 / 0.190	= 0.07
R_9'' [m²K/W] = d_9/λ_9 =	0.0030 / 0.570	= 0.01
R_{si} [m²K/W]		= 0.13

$$R_T'' = \sum R_i'' + R_{si} + R_{se} = 6.92\ m^2K/W$$

OUTSIDE INSIDE



The list of material layers shown below may differ from those in the U-value calculation printout. Only material layers which are used in the Condensation Risk Analysis are listed.

This calculation of the Condensation risk analysis according to BS EN ISO 13788 has been performed on a construction containing inhomogeneous layers. This calculation is only valid through the selected section. It is advisable that you should also select the alternative position and recalculate the Condensation Risk Analysis for a more complete assessment of the construction. For further information the user is advised to follow the guidance in BS 5250:2021 Management of moisture in buildings

Assignment: External wall

Name	Thickn. [m]	lambda [W/(mK)]	Q	μ [-]	Q	sd [m]	R [m²K/W]
Render, cement and sand	0.0100	1.000	D	6.00	D	0.06	0.0100
Concrete block (dense) outer leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.210	D	120.00	D	12.00	0.0826
XtroLiner XO/RS Rainscreen	0.0900	0.021	C	20.00	C	1.80	4.2857
Concrete block (dense) inner leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.130	D	120.00	D	12.00	0.0885
Low E airspace	0.0350	0.034	E	1.00	E	0.04	1.0294
Air-Reflect	0.0120	0.031	E	29231.00	E	350.77	0.3871
Low E airspace	0.0400	0.034	E	1.00	E	0.04	1.1765
Gyproc HandiBoard	0.0125	0.190	D	4.00	D	0.05	0.0658
Gypsum plastering	0.0030	0.570	D	6.00	D	0.02	0.0053

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
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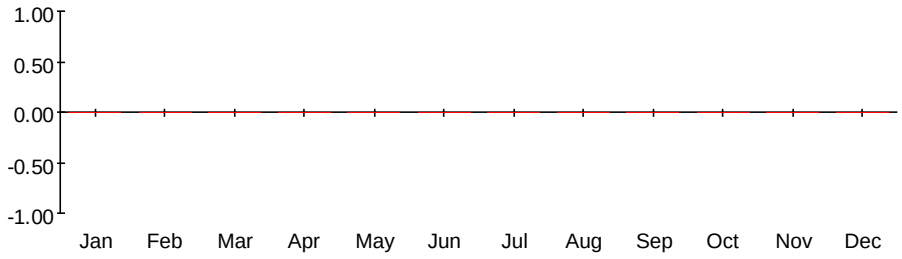
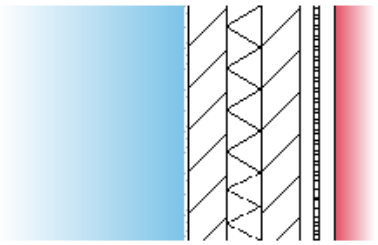
Condensation risk analysis - summary of main results
Calculation according BS EN ISO 13788

Surface temperature to avoid critical surface moisture:
No danger of mould growth is expected.

Interstitial condensation:
No condensation is predicted at any interface in any month.

Interstitial condensation and evaporation per month gc [g/m²]





Component, condensation range

Condensation Risk Analysis calculations according to BS EN ISO 13788 are used as a guide in predicting interstitial condensation. This methodology uses some simplifications of the dynamic processes involved and subsequently does have some limitations. For further information the user is advised to follow the prescriptive guidance in BS 5250:2021 Management of moisture in buildings – Code of practice & BRE Information Paper:IP2/O5 (Feb. 2005) 'Modelling and controlling interstitial condensation

Surface temperature to avoid critical surface humidity
Calculation according BS EN ISO 13788

Location: Armagh (2000 to 2019); Humidity class according BS EN ISO 13788 annex A: 3 Buildings with unknown occupancy; Return period according BS 5250:2021 Once in 10 years (-1°C Ext Temp, +4% Ext RH)

	1	2	3	4	5	6	7	8	9	10	11	12
Month	Te [°C]	phi_e ---	Ti [°C]	phi_i ---	pe [Pa]	delta p [Pa]	pi [Pa]	ps(Tsi) [Pa]	Tsi,min [°C]	fRsi ---	Tsi [°C]	Tse [°C]
January	4.0	0.870	20.0	0.588	707	668	1375	1719	15.1	0.696	19.5	4.1
February	4.3	0.850	20.0	0.583	706	657	1363	1704	15.0	0.681	19.5	4.4
March	5.7	0.820	20.0	0.581	751	608	1358	1698	14.9	0.646	19.5	5.8
April	7.9	0.790	20.0	0.587	841	530	1371	1714	15.1	0.594	19.6	8.0
May	10.6	0.790	20.0	0.617	1009	434	1443	1804	15.9	0.562	19.7	10.7
June	13.3	0.790	20.0	0.661	1206	338	1544	1930	16.9	0.544	19.8	13.3
July	14.8	0.800	20.0	0.698	1346	285	1631	2038	17.8	0.579	19.8	14.8
August	14.5	0.820	20.0	0.705	1353	295	1649	2061	18.0	0.633	19.8	14.5
September	12.7	0.840	20.0	0.681	1233	359	1592	1990	17.4	0.648	19.8	12.7
October	9.5	0.860	20.0	0.639	1021	473	1493	1867	16.4	0.659	19.6	9.6
November	6.2	0.870	20.0	0.605	824	590	1414	1768	15.6	0.679	19.5	6.3
December	4.3	0.880	20.0	0.594	731	657	1388	1735	15.3	0.699	19.5	4.4

- The critical month is December with $f_{Rsi,max}$ = 0.699
  f_{Rsi} = 0.966

$f_{Rsi} > f_{Rsi,max}$, the component complies.

Nr Explanation

1 External temperature
2 External rel. humidity
3 Internal temperature
4 Internal relative humidity
5 External partial pressure $p_e = \phi_e * p_{sat}(T_e)$; $p_{sat}(T_e)$ according formula E.7 and E.8 of BS EN ISO 13788
6 Partial pressure difference. The security factor of 1.10 according to BS EN ISO 13788, ch.4.2.4 is already included.
7 Internal partial pressure $p_i = \phi_i * p_{sat}(T_i)$; $p_{sat}(T_i)$ according formula E.7 and E.8 of BS EN ISO 13788
8 Minimum saturation pressure on the surface obtained by $p_{sat}(T_{si}) = p_i / \phi_{si}$,
where ϕ_{si} = 0.8 (critical surface humidity)
9 Minimum surface temperature as function of $p_{sat}(T_{si})$, formula E.9 and E.10 of BS EN ISO 13788
10 Design temperature factor according 3.1.2 of BS EN ISO 13788
11 Internal surface temperature, obtained from $T_{si} = T_i - R_{si} * U * (T_i - T_e)$
12 External surface temperature, obtained from $T_{se} = T_e + R_{se} * U * (T_i - T_e)$

Interstitial condensation - main results
Calculation according BS EN ISO 13788

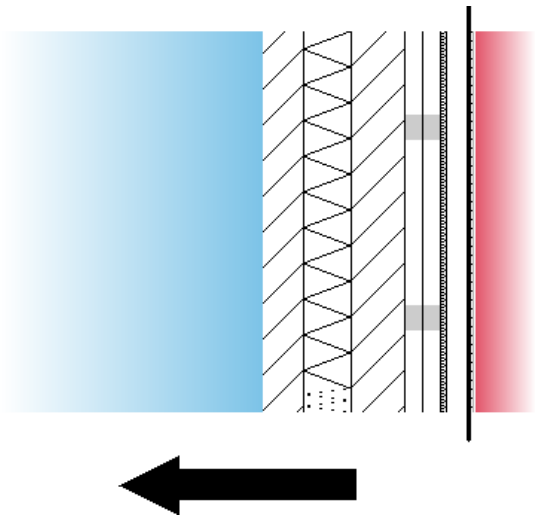
No condensation is predicted at any interface in any month.

Climatic conditions
Location: Armagh (2000 to 2019); Humidity class according BS EN ISO 13788 annex A: 3 Buildings with unknown occupancy; Return period according BS 5250:2021 Once in 10 years (-1°C Ext Temp, +4% Ext RH)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	58.8	58.3	58.1	58.7	61.7	66.1	69.8	70.5	68.1	63.9	60.5	59.4
External temperature [°C]	Te	4.0	4.3	5.7	7.9	10.6	13.3	14.8	14.5	12.7	9.5	6.2	4.3
External rel. humidity [%]	phi_e	87.0	85.0	82.0	79.0	79.0	79.0	80.0	82.0	84.0	86.0	87.0	88.0

Source: **Airgreen 1**
Component: **New external wall**

OUTSIDE INSIDE



The list of materials shown below may differ from those in the U-value calculation printout. Only material layers which are used in the heat capacity calculation are listed.

Single material layers shown in the U-value calculation printout may be separated to meet the exclusion criteria:

A .. The total thickness of the layers exceed 0.1 m.
B .. The mid point in the construction is reached.

For insulation layers the following criteria applies:

C .. An insulating layer is reached (defined as lambda <= 0.08 W/(mK)).

	Name	Thickness [m]	lambda [W/(mK)]	Q	Thermal capacity [kJ/(kgK)]	Q	Density [kg/m³]	Q	Thermal mass kJ/(m²K)	Criteria Exclusion
	End of calculation - Cold									
1	Render, cement and sand	0.0100	1.000	D	1.00	D	1800.0	D	~~18.0~~	A, -, C
2	Concrete block (dense) outer leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.210	D	1.00	D	1800.0	D	~~180.0~~	A, -, C
3	XtroLiner XO/RS Rainscreen	0.0900	0.021	C	1.40	C	32.0	C	~~0.0~~	A, -, C
4	Concrete block (dense) inner leaf (1800 kg/m³) & Mortar outer leaf (f = 0.000 / automatic disregard acc. BRE 443)	0.1000	1.130	D	1.00	D	1800.0	D	~~180.0~~	A, -, C
5	Inhomogeneous material layer consisting of:	0.0025							~~0.2~~	A, -, C
5a	Low E airspace	88.00%	0.034	E	1.01	E	1.2	E	~~0.0~~	A, -, C
5b	Softwood Timber [500 kg/m³]	12.00%	0.130	D	1.60	D	500.0	D	~~0.2~~	A, -, C
5	Inhomogeneous material layer consisting of:	0.0325							~~3.1~~	-, -, C
5a	Low E airspace	88.00%	0.034	E	1.01	E	1.2	E	~~0.0~~	-, -, C
5b	Softwood Timber [500 kg/m³]	12.00%	0.130	D	1.60	D	500.0	D	~~3.1~~	-, -, C
6	Air-Reflect	0.0120	0.031	E	0.88	E	57.6	E	~~0.0~~	-, -, C
7	Inhomogeneous material layer consisting of:	0.0400							~~1.3~~	-, -, C
7a	Low E airspace	96.00%	0.034	E	1.01	E	1.2	E	~~0.0~~	-, -, C
7b	Softwood Timber [500 kg/m³]	04.00%	0.130	D	1.60	D	500.0	D	1.3	-, -, -
8	Gyproc HandiBoard	0.0125	0.190	D	1.00	D	680.0	D	8.5	-, -, -
9	Gypsum plastering	0.0030	0.570	D	1.00	D	1300.0	D	3.9	-, -, -
	Start of calculation - Warm									
		0.4025							**12.4**	

Heat capacity = 12.4 kJ/(m²K)

The following exclusion criteria apply:
A .. The total thickness of the layers exceed 0.1 m.
C .. An insulating layer is reached (defined as lambda <= 0.08 W/(mK)).

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
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