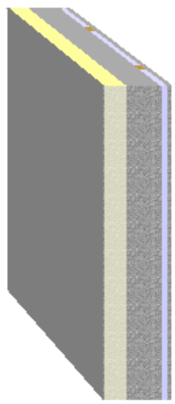
Documentation of the component
Thermal transmittance (U-value) according to BS EN ISO 6946
Source: **own catalogue - Non Traditional**
Component: **Bison Beam Property**

OUTSIDE INSIDE



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

Assignment: External wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0400
☑	1	WBS	WBS Silicone Render	0.0100	0.532	E	0.0188
☑	2	WBS	WBS PIR	0.0800	0.026	E	3.0769
		Fixings	Plastic insulation anchors No./m²:	8/m²	0.500	D	-
		Fixings	equivalent diameter: 0.01 m / alpha: 0.800				
		Air gaps	Level 1: dU" = 0.01 W/(m²K)				
☑	3	Own catalogue	Concrete, Medium density 2200	0.1300	1.750	E	0.0743
☑	4	Inhomogeneous material layer	consisting of:	0.0200	ø 0.138		0.1449
	4a	Own catalogue	Normal cavity - 20 mm, unventilated	89.00 %	0.139	E	-
	4b	BS EN 12524	Softwood Timber [500 kg/m³]	11.00 %	0.130	D	-
☑	5	Own catalogue	Standard Plasterboard	0.0125	0.250	E	0.0500
		Rsi					0.1300
				0.2525			

$R_T = (R_T' + R_T'')/2 = 3.53$ m²K/W

Correction to U-value for	according to	delta U [W/(m²K)]
Mechanical fasteners	BS EN ISO 6946 Annex D	~~0.000~~
Air gaps	BS EN ISO 6946 Annex D	~~0.008~~
Air gaps and fixings corrections need not be applied, as their total effect is less than 3% (Annex D BS 6946:1996).		
		0.000

$U = 1/R_T + \Sigma\Delta U = 0.28$ W/(m²K)

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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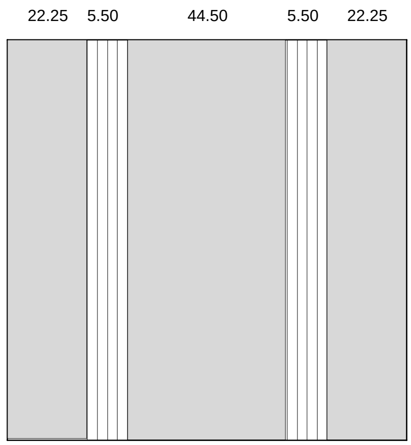
U_{max} = **0.30** W/(m²K) U = **0.28** W/(m²K) R_T= **3.53** m²K/W

Source of Umax value: England and Wales Approved Document L1A 2010 Tab 2 Dwellings New

Source: **own catalogue - Non Traditional**

Component: **Bison Beam Property**

Draft of the component (portion in %):



The inhomogeneous layer consists of two zones (A, B).
The portion is given in %.

A	22.25 + 44.50 + 22.25 consisting of material layers: 1, 2, 3, 4a, 5	= 89.00%
B	5.50 + 5.50 consisting of material layers: 1, 2, 3, 4b, 5	= 11.00%

Upper limit of the thermal transfer resistance R

U_A [W/(m²K)] = $\frac{1}{(\Sigma R_{i,A}) + R_{si} + R_{se}} = \frac{1}{3.36 + 0.13 + 0.04}$ = 0.28

U_B [W/(m²K)] = $\frac{1}{(\Sigma R_{i,B}) + R_{si} + R_{se}} = \frac{1}{3.37 + 0.13 + 0.04}$ = 0.28

$$R_T' = \frac{1}{A * U_A + B * U_B} = 3.53 \text{ m}^2\text{K/W}$$

Lower limit of the thermal transfer resistance R

R_{se} [m²K/W]		= 0.04
R_1'' [m²K/W] = d_1 / λ_1=	0.0100 / 0.532	= 0.02
R_2'' [m²K/W] = d_2 / λ'_2=	0.0800 / 0.026	= 3.08
R_3'' [m²K/W] = d_3 / λ_3=	0.1300 / 1.750	= 0.07
R_4'' [m²K/W] = $d_4 / (\lambda_{4a} * A + \lambda_{4b} * B)$ =	0.0200 /(0.139 * 89.00% + 0.130 * 11.00%)	= 0.14
R_5'' [m²K/W] = d_5 / λ_5=	0.0125 / 0.250	= 0.05
R_{si} [m²K/W]		= 0.13

$$R_T'' = \Sigma R_i'' + R_{si} + R_{se} = 3.53 \text{ m}^2\text{K/W}$$

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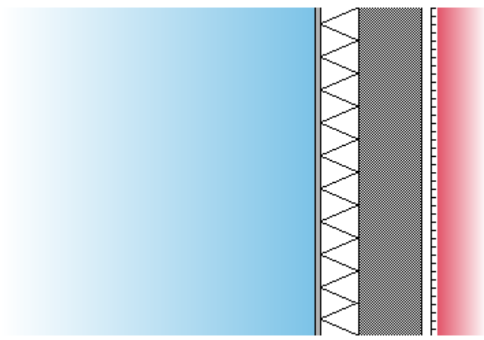
Component: **Bison Beam Property**

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 13788:2002 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.

Assignment: External wall

Name	Thickn. [m]	lambda [W/(mK)]	Q	µ [-]	Q	sd [m]	R [m²K/W]
WBS Silicone Render	0.0100	0.532	E	6.00	E	0.06	0.0188
WBS PIR	0.0800	0.026	E	50.00	E	4.00	3.0769
Concrete, Medium density 2200	0.1300	1.750	E	70.00	E	9.10	0.0743
Normal cavity - 20 mm, unventilated	0.0200	0.139	E	1.00	E	0.02	0.1439
Standard Plasterboard	0.0125	0.250	E	4.00	E	0.05	0.0500

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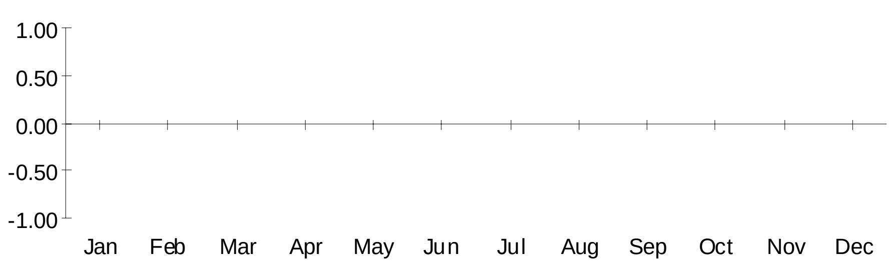
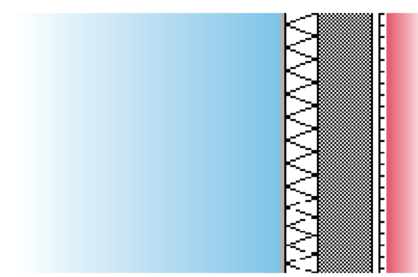
Condensation risk analysis - summary of main results
Calculation according BS EN ISO 13788

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

CRA calculations according to BS EN ISO 13788:2002 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. Further information can be found in Information Paper IP 2/05 'Modelling and controlling interstitial condensation in buildings" Feb 2005.

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

Location: Manchester Airport; Humidity class according BS EN ISO 13788 annex A: Dwellings with low occupancy

		1	2	3	4	5	6	7	8	9	10	11	12
	Month	Te	phi_e	Ti	phi_i	pe	delta p	pi	ps(Tsi)	Tsi,min	fRsi	Tsi	Tse
		[°C]	---	[°C]	---	[Pa]	[Pa]	[Pa]	[Pa]	[°C]	---	[°C]	[°C]
●	January	4.2	0.830	20.0	0.594	684	704	1388	1735	15.3	0.701	18.9	4.4
	February	4.1	0.800	20.0	0.583	655	708	1363	1704	15.0	0.685	18.9	4.3
	March	5.8	0.760	20.0	0.570	701	633	1333	1666	14.7	0.623	19.0	6.0
	April	7.8	0.710	20.0	0.554	751	544	1294	1618	14.2	0.524	19.2	7.9
	May	11.3	0.680	20.0	0.555	910	388	1298	1622	14.2	0.337	19.4	11.4
	June	14.1	0.710	20.0	0.601	1142	263	1405	1756	15.5	0.231	19.6	14.2
	July	16.1	0.720	20.0	0.638	1317	174	1491	1863	16.4	0.075	19.7	16.1
	August	15.8	0.740	20.0	0.648	1328	187	1515	1894	16.6	0.201	19.7	15.8
	September	13.3	0.770	20.0	0.631	1175	298	1474	1842	16.2	0.435	19.5	13.4
	October	10.3	0.810	20.0	0.619	1014	432	1446	1808	15.9	0.579	19.3	10.4
	November	6.7	0.820	20.0	0.598	804	593	1397	1746	15.4	0.652	19.1	6.8
	December	5.2	0.840	20.0	0.600	743	659	1402	1752	15.4	0.691	19.0	5.4

● The critical month is January with $f_{Rsi,max}$ = 0.701
f_{Rsi} = 0.932

$f_{Rsi} > f_{Rsi,max}$, 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.

Climcatic conditions
Location: Manchester Airport; Humidity class according BS EN ISO 13788 annex A: Dwellings with low occupancy

		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	59.4	58.3	57.0	55.4	55.5	60.1	63.8	64.8	63.1	61.9	59.8	60.0
External temperature [°C]	Te	4.2	4.1	5.8	7.8	11.3	14.1	16.1	15.8	13.3	10.3	6.7	5.2
External rel. humidity [%]	phi_e	83.0	80.0	76.0	71.0	68.0	71.0	72.0	74.0	77.0	81.0	82.0	84.0

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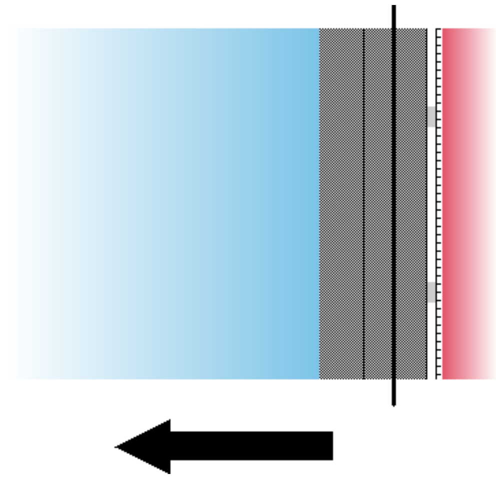
Component: **Bison Beam Property**

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	WBS Silicone Render	0.0100	0.532	E	1.00	E	1800.0	E	~~18.0~~	A, -, C
2	WBS PIR	0.0800	0.026	E	1.40	E	30.0	E	~~0.0~~	A, -, C
3	Concrete, Medium density 2200	0.0625	1.750	E	1.00	E	2200.0	E	~~137.5~~	A, -, -
3	Concrete, Medium density 2200	0.0675	1.750	E	1.00	E	2200.0	E	148.5	-, -, -
4	Inhomogeneous material layer consisting of:	0.0200							1.8	-, -, -
4a	Normal cavity - 20 mm, unventilated	89.00%	0.139	E	1.01	E	1.3	E	0.0	-, -, -
4b	Softwood Timber [500 kg/m³]	11.00%	0.130	D	1.60	D	500.0	D	1.8	-, -, -
5	Standard Plasterboard	0.0125	0.250	E	1.00	E	900.0	E	11.3	-, -, -
	Start of calculation - Warm									
		0.2525							**161.5**	

Heat capacity = 161.5 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)).

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