

**Project Information**

Reference

Date 14 September 2018

**Construction Type**

Element : Flat roof - 0 Spec generator copies

Internal surface emissivity : High External surface emissivity : High

	Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m <sup>2</sup> K/W)	Pitch (°)	Bridge details Air gaps (Level, Delta U")
Outside surface resistance	-	-	0.100		
Zinc	0.5	111.111	0.000		
Plywood (500 kg/m <sup>3</sup> )	18.0	0.130	0.000		
Airspace, heat flow upwards, 50 mm thick	50.0	-	0.000		
Ampatex Aero	-	-	-		
Beltermo Ultra	60.0	0.042	1.400		L:0 0.000W/m <sup>2</sup> K
SteicoFlex	200.0	0.036	5.550		9.000% Softwood (200.0mm) L:0 0.000W/m <sup>2</sup> K
Ampatex DB90	-	-	-		
Airspace, heat flow upwards, 25 mm thick	25.0	-	0.160		
Gyproc Wallboard	12.5	0.189	0.066		
Inside surface resistance	-	-	0.100		
<b>Total thickness</b>	<b>366.0mm</b>				

**U-value = 0.15W/m<sup>2</sup>K**

U-value, Combined Method : 0.154W/m<sup>2</sup>K (upper/lower limit 6.661 / 6.321m<sup>2</sup>K/W, dUf 0.0000, dUg 0.0000, dUp0.0000, dUr0.0000, dUrc1 0.0000, dUrc2 0.0000)

**Correction factors**

Air gaps, Delta Ug = 0.000W/m<sup>2</sup>K

(Based on the combined method for determining U-values of structures containing repeating thermal bridges)

	Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m <sup>2</sup> K/W)	Vapour Resistivity (MNs/gm)	Vapour Resistance (MNs/g)
Outside surface resistance	-	-	0.100	-	-
Zinc	0.5	111.111	0.000	-	100000
Plywood (500 kg/m <sup>3</sup> )	18.0	0.130	0.000	1000.00	18.00
Airspace, heat flow upwards, 50 mm thick	50.0	-	0.000	-	0.00
Ampatex Aero	-	-	-	-	0.20
Beltermo Ultra	60.0	0.042	1.400	15.00	0.90
SteicoFlex	200.0	0.036	5.550	5.00	1.00
Ampatex DB90	-	-	-	-	100.00
Airspace, heat flow upwards, 25 mm thick	25.0	-	0.160	-	0.00
Gyproc Wallboard	12.5	0.189	0.066	50.00	0.63
Inside surface resistance	-	-	0.100	-	-
<b>Total thickness</b>	<b>366.0mm</b>				

## Detailed U-value Calculation Results

Construction includes 1 bridged layer

### Non-bridged layers

Outside surface resistance	0.100 m <sup>2</sup> K/W
Beltermo Ultra	1.400 m <sup>2</sup> K/W
Airspace, heat flow upwards, 25 mm thick	0.160 m <sup>2</sup> K/W
Gyproc Wallboard	0.066 m <sup>2</sup> K/W
Inside surface resistance	0.100 m <sup>2</sup> K/W
<u>Resistance of non-bridged layers, R<sub>NB</sub> =</u>	<u>1.826 m<sup>2</sup>K/W</u>

### Bridged layer

SteicoFlex (L1) bridged by Softwood (B1)

Path 1 - SteicoFlex

Path 2 - Softwood

### Resistance and fraction of heat flow paths

$$R_{P1} = R_{NB} + R_{L1} = 1.826 + 5.550 = 7.376 \text{ m}^2\text{K/W} \quad F_{P1} = 91.000\%$$

$$R_{P2} = R_{NB} + R_{L2} = 1.826 + 1.538 = 3.364 \text{ m}^2\text{K/W} \quad F_{P2} = 9.000\%$$

### Upper resistance limit

$$R_{\text{upper}} = 1 / \left( \frac{F_{P1}}{R_{P1}} + \frac{F_{P2}}{R_{P2}} \right)$$

$$R_{\text{upper}} = 1 / \left( \frac{0.910}{7.376} + \frac{0.090}{3.364} \right) = 6.661 \text{ m}^2\text{K/W}$$

### Lower resistance limit

$$R_{\text{lower}} = R_{NB} + 1 / \left( \frac{F_{L1}}{R_{L1}} + \frac{F_{B1}}{R_{B1}} \right)$$

$$R_{\text{lower}} = 1.826 + 1 / \left( \frac{0.910}{5.550} + \frac{0.090}{1.538} \right) = 6.321 \text{ m}^2\text{K/W}$$

### Total resistance of roof

$$R_T = (R_{\text{upper}} + R_{\text{lower}}) / 2 = (6.661 + 6.321) / 2 = 6.49 \text{ m}^2\text{K/W}$$

Correction for air gaps, Delta Ug = 0.0000W/m<sup>2</sup>K

(Delta Uf + Delta Ug + Delta Up + Delta Ur) is less than 3% of (1 / Rt) so U = (1 / Rt) + (Delta Ur) + (Delta Urc) = 0.15 W/m<sup>2</sup>K

Structure element : Flat roof  
Condensation calculations performed in accordance with BS5250:2011

**Condensation is occurring at the following layers interfaces:-**

Interface 1 : Ampatex Aero / Beltermo Ultra

Month	Int (C°)	Int (%RH)	Ext (C°)	Ext (%RH)	Interface 1	
					Gc (Kg/m <sup>2</sup> )	Ma (Kg/m <sup>2</sup> )
Jan	21.00	56.10	5.90	85.50	0.01183	0.03533
Feb	21.00	55.20	5.70	83.50	0.01046	0.04579
Mar	21.00	55.50	6.90	82.00	0.00971	0.05551
Apr	21.00	56.20	8.80	79.50	0.00637	0.06188
May	21.00	59.30	11.50	79.00	0.00277	0.06465
Jun	21.00	64.30	14.30	79.50	-0.00103	0.06362
Jul	21.00	68.80	16.10	80.50	-0.00332	0.06030
Aug	21.00	69.30	16.00	81.50	-0.00269	0.05761
Sep	21.00	66.60	14.30	83.00	0.00042	0.00042
Oct	21.00	63.20	11.90	85.00	0.00436	0.00478
Nov	21.00	58.20	8.50	84.50	0.00820	0.01299
Dec	21.00	57.00	7.00	85.50	0.01051	0.02350

Gc = Monthly moisture accumulation per area at an interface

Ma = Accumulated moisture content per area at an interface

Peak accumulated moisture content per area at interface (Ma) = 0.06465 Kg/m<sup>2</sup>

Annual moisture accumulation = 0.05761 Kg/m<sup>2</sup>

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**Thermal Mass Details**

	Thickness assessed (actual) (mm)	Density (kg/m <sup>3</sup> )	Specific heat capacity (J/kgK)	Heat capacity (kJ/m <sup>2</sup> K)
Zinc	0.0 (0.5)	7200.0	110.0	0.0
Plywood (500 kg/m <sup>3</sup> )	0.0 (18.0)	500.0	1600.0	0.0
Airspace, heat flow upwards, 50 mm thick	0.0 (50.0)	1.2	1008.0	0.0
Ampatex Aero	0.0 (-)	300.0	850.0	0.0
Beltermo Ultra	0.0 (60.0)	180.0	2100.0	0.0
SteicoFlex	0.0 (200.0)	60.0	2100.0	0.0
Ampatex DB90	0.0 (-)	280.0	850.0	0.0
Airspace, heat flow upwards, 25 mm thick	25.0 (25.0)	1.2	1008.0	30240.0
Gyproc Wallboard	12.5 (12.5)	950.0	850.0	10093750.0

Total 10123990.0

kappa value 10.1240

Limiting condition: insulation

Admittance : 1.09 W/m<sup>2</sup>K    Decrement : 0.28 factor    Decrement delay : -11.67 hours

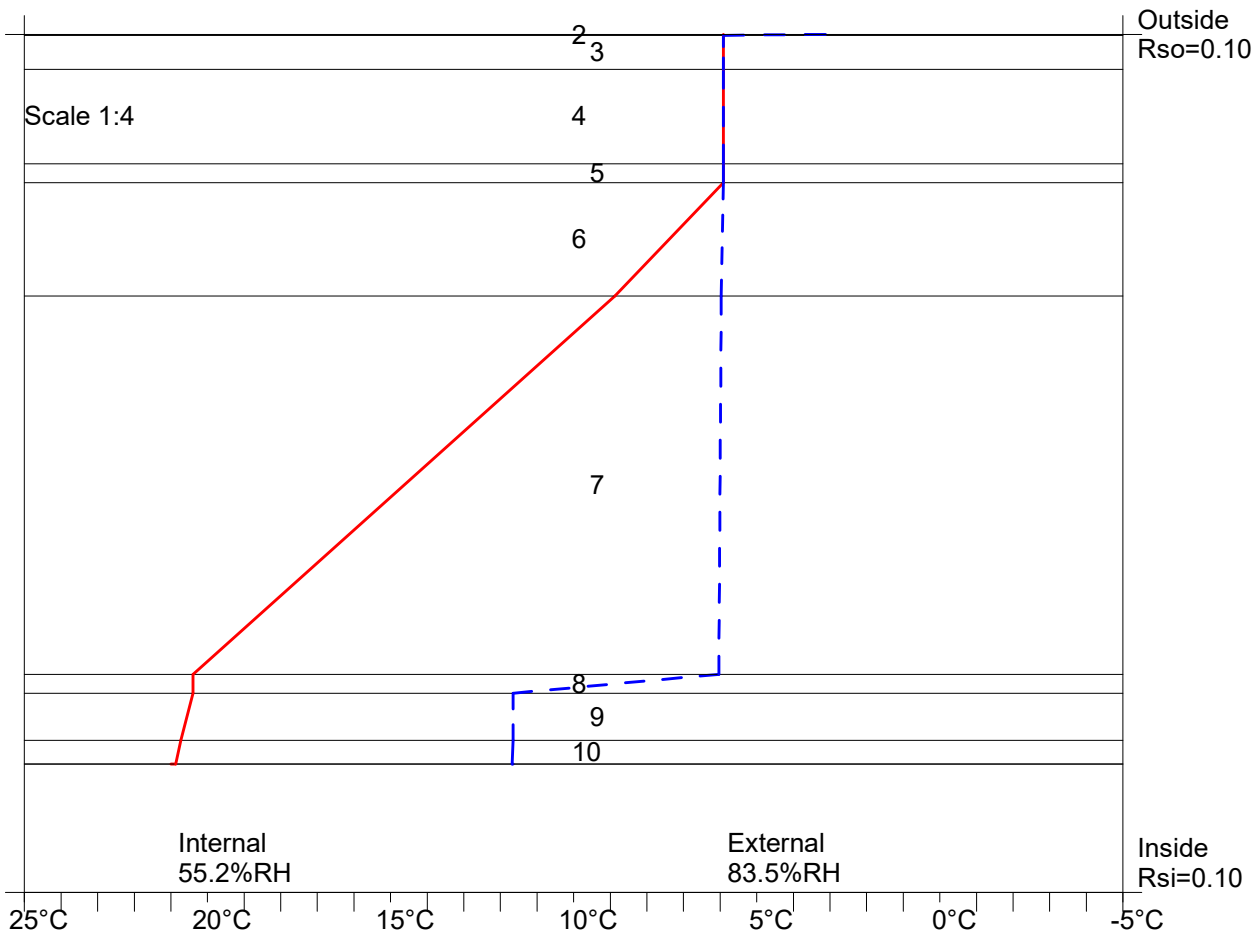
**Condensation Risk Analysis (no account taken of thermal bridges)**

**3 - Dwellings with low occupancy**

Jan	Feb (worst)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.0C 56.1%	21.0C 55.2%	21.0C 55.5%	21.0C 56.2%	21.0C 59.3%	21.0C 64.3%	21.0C 68.8%	21.0C 69.3%	21.0C 66.6%	21.0C 63.2%	21.0C 58.2%	21.0C 57.0%
5.9C 85.5%	5.7C 83.5%	6.9C 82.0%	8.8C 79.5%	11.5C 79.0%	14.3C 79.5%	16.1C 80.5%	16.0C 81.5%	14.3C 83.0%	11.9C 85.0%	8.5C 84.5%	7.0C 85.5%

	Interface Temp. °C	Dewpoint Temp. °C	Vapour Pressure (kPa)	Saturated V.P. (kPa)	Worst Cond. (g/m <sup>2</sup> )	Peak Buildup (g/m <sup>2</sup> )	Condensation
1 Outside surface resistance							
2 Zinc	5.9	3.1	0.76	0.93			No
3 Plywood (500 kg/m <sup>3</sup> )	5.9	5.9	0.93	0.93		0 in May	No
4 Airspace, heat flow upwards, 50 mm thick	5.9	5.9	0.93	0.93			No
5 Ampatex Aero	5.9	5.9	0.93	0.93			No
6 Beltermo Ultra	8.9	6.0	0.93	1.14	12 in Jan	65 in May	Yes
7 SteicoFlex	20.4	6.0	0.94	2.39			No
8 Ampatex DB90	20.4	11.7	1.37	2.39			No
9 Airspace, heat flow upwards, 25 mm thick							
10 Gyproc Wallboard	20.7	11.7	1.37	2.44			No
11 Inside surface resistance	20.9	11.7	1.37	2.47			No

Worst case internal / external conditions for graph : 21.0°C @ 55.2%RH / 5.7°C @ 83.5%RH



**Condensation Risk Analysis (no account taken of thermal bridges)**

**3 - Dwellings with low occupancy**

Jan	Feb (worst)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.0C 56.1%	21.0C 55.2%	21.0C 55.5%	21.0C 56.2%	21.0C 59.3%	21.0C 64.3%	21.0C 68.8%	21.0C 69.3%	21.0C 66.6%	21.0C 63.2%	21.0C 58.2%	21.0C 57.0%
5.9C 85.5%	5.7C 83.5%	6.9C 82.0%	8.8C 79.5%	11.5C 79.0%	14.3C 79.5%	16.1C 80.5%	16.0C 81.5%	14.3C 83.0%	11.9C 85.0%	8.5C 84.5%	7.0C 85.5%

	Interface Temp. °C	Dewpoint Temp. °C	Vapour Pressure (kPa)	Saturated V.P. (kPa)	Worst Cond. (g/m <sup>2</sup> )	Peak Buildup (g/m <sup>2</sup> )	Condensation
1 Outside surface resistance							
2 Zinc	16.2	12.8	1.47	1.84			No
3 Plywood (500 kg/m <sup>3</sup> )	16.2	15.1	1.71	1.84		0 in May	No
4 Airspace, heat flow upwards, 50 mm thick	16.2	15.1	1.71	1.84			No
5 Ampatex Aero	16.2	15.1	1.71	1.84			No
6 Beltermo Ultra	16.2	15.1	1.71	1.84	12 in Jan	65 in May	Yes
7 SteicoFlex	17.1	15.1	1.71	1.95			No
8 Ampatex DB90	20.8	15.1	1.71	2.46			No
9 Airspace, heat flow upwards, 25 mm thick	20.8	15.1	1.71	2.46			No
10 Gyproc Wallboard	20.9	15.1	1.71	2.47			No
11 Inside surface resistance	21.0	15.1	1.71	2.48			No

Worst case internal / external conditions for graph : 21.0°C @ 68.8%RH / 16.1°C @ 80.5%RH

