

## Back to Earth SW Ltd

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### Project Information

Reference

Date 14 September 2018

### Construction Type

Element :

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	-	-	0.130		
Airspace, heat flow horizontal, 50 mm thick	50.0	-	0.000		
Beltermo Ultra	40.0	0.042	0.950		L:0 0.000W/m <sup>2</sup> K
SteicoFlex	150.0	0.036	4.150		12.500% Prefabricated panels (150.0mm) L:0 0.000W/m <sup>2</sup> K
Ampatex Sinco	-	-	-		
Airspace, heat flow horizontal, 25 mm thick	25.0	-	0.180		
Oriented strandboard (OSB)	11.0	0.130	0.085		
Gyproc Wallboard	12.5	0.190	0.066		
Airspace, heat flow horizontal, 25 mm thick	25.0	-	0.180		11.800% Softwood (25.0mm)
Inside surface resistance	-	-	0.130		
<b>Total thickness</b>	<b>313.5mm</b>				

### U-value = 0.20W/m<sup>2</sup>K

U-value, Combined Method : 0.197W/m<sup>2</sup>K (upper/lower limit 5.234 / 4.939m<sup>2</sup>K/W, dUf 0.0022, dUg 0.0000, dUp0.0000, dUr0.0000, dUrc1 0.0000, dUrc2 0.0000)

### Correction factors

Mechanical fasteners :-

Warm pitched roof - insulation over rafters

Alpha : 0.80 per m lambda f : 50.0000W/mK nf : 6.700 per m<sup>2</sup> Af : 12.500mm<sup>2</sup> Recess : 0.0mm

Delta Uf for Beltermo Ultra : 0.0022

nf = fasteners per m<sup>2</sup> Af = fasteners cross-sectional area

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	-	-	0.130	-	-
Airspace, heat flow horizontal, 50 mm thick	50.0	-	0.000	-	0.00
Beltermo Ultra	40.0	0.042	0.950	15.00	0.60
SteicoFlex	150.0	0.036	4.150	5.00	0.75
Ampatex Sinco	-	-	-	-	25.00
Airspace, heat flow horizontal, 25 mm thick	25.0	-	0.180	-	0.00
Oriented strandboard (OSB)	11.0	0.130	0.085	250.00	2.75
Gyproc Wallboard	12.5	0.190	0.066	50.00	0.63
Airspace, heat flow horizontal, 25 mm thick	25.0	-	0.180	-	0.00
Inside surface resistance	-	-	0.130	-	-
<b>Total thickness</b>	<b>313.5mm</b>				

## Detailed U-value Calculation Results

Construction includes 2 bridged layers

### Non-bridged layers

Outside surface resistance	0.130 m <sup>2</sup> K/W
Beltermo Ultra	0.950 m <sup>2</sup> K/W
Airspace, heat flow horizontal, 25 mm thick	0.180 m <sup>2</sup> K/W
Oriented strandboard (OSB)	0.085 m <sup>2</sup> K/W
Gyproc Wallboard	0.066 m <sup>2</sup> K/W
Inside surface resistance	0.130 m <sup>2</sup> K/W
<b>Resistance of non-bridged layers, R<sub>NB</sub> =</b>	<b>1.541 m<sup>2</sup>K/W</b>

### Bridged layers

SteicoFlex (L1) bridged by Prefabricated panels (B1)

Airspace, heat flow horizontal, 25 mm thick (L2) bridged by Softwood (B2)

Path 1 - SteicoFlex

Path 2 - Prefabrica

Path 3 - SteicoFlex

Path 4 - Prefabrica

### Resistance and fraction of heat flow paths

$$R_{P1} = R_{NB} + R_{L1} = 1.541 + 4.330 = 5.871 \text{ m}^2\text{K/W} \quad F_{P1} = 77.175\%$$

$$R_{P2} = R_{NB} + R_{L2} = 1.541 + 1.430 = 2.971 \text{ m}^2\text{K/W} \quad F_{P2} = 11.025\%$$

$$R_{P3} = R_{NB} + R_{L3} = 1.541 + 4.342 = 5.883 \text{ m}^2\text{K/W} \quad F_{P3} = 10.325\%$$

$$R_{P4} = R_{NB} + R_{L4} = 1.541 + 1.442 = 2.983 \text{ m}^2\text{K/W} \quad F_{P4} = 1.475\%$$

### Upper resistance limit

$$R_{\text{upper}} = 1 / \left( \frac{F_{P1}}{R_{P1}} + \frac{F_{P2}}{R_{P2}} + \frac{F_{P3}}{R_{P3}} + \frac{F_{P4}}{R_{P4}} \right)$$

$$R_{\text{upper}} = 1 / \left( \frac{0.772}{5.871} + \frac{0.110}{2.971} + \frac{0.103}{5.883} + \frac{0.015}{2.983} \right) = 5.234 \text{ m}^2\text{K/W}$$

### Lower resistance limit

$$R_{\text{lower}} = R_{NB} + 1 / \left( \frac{F_{L1}}{R_{L1}} + \frac{F_{B1}}{R_{B1}} \right) + 1 / \left( \frac{F_{L2}}{R_{L2}} + \frac{F_{B2}}{R_{B2}} \right)$$

$$R_{\text{lower}} = 1.541 + 1 / \left( \frac{0.875}{4.150} + \frac{0.125}{1.250} \right) + 1 / \left( \frac{0.882}{0.180} + \frac{0.118}{0.192} \right) = 4.939 \text{ m}^2\text{K/W}$$

### Total resistance of wall

$$R_T = (R_{\text{upper}} + R_{\text{lower}}) / 2 = (5.234 + 4.939) / 2 = 5.09 \text{ m}^2\text{K/W}$$

### Mechanical fasteners :-

Calculations to BS EN ISO 6946:2007

Warm pitched roof - insulation over rafters

Alpha : 0.80 per m    lambda f : 50.0000W/mK    nf : 6.700 per m<sup>2</sup>    Af : 12.500mm<sup>2</sup>    Recess : 0.0mm

Delta Uf for Beltermo Ultra : 0.0022

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) = 0.20 W/m<sup>2</sup>K

Structure element : Wall  
Condensation calculations performed in accordance with BS5250:2011

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

Month	Int (C°)	Int (%RH)	Ext (C°)	Ext (%RH)
Jan	20.00	51.50	5.90	85.50
Feb	20.00	50.40	5.70	83.50
Mar	20.00	51.50	6.90	82.00
Apr	20.00	53.30	8.80	79.50
May	20.00	58.10	11.50	79.00
Jun	20.00	65.10	14.30	79.50
Jul	20.00	71.00	16.10	80.50
Aug	20.00	71.40	16.00	81.50
Sep	20.00	67.50	14.30	83.00
Oct	20.00	62.60	11.90	85.00
Nov	20.00	55.20	8.50	84.50
Dec	20.00	53.20	7.00	85.50

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) = 0.00000 Kg/m<sup>2</sup>

Annual moisture accumulation = 0.00000 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)
Airspace, heat flow horizontal, 50 mm thick	0.0 (50.0)	1.2	1008.0	0.0
Beltermo Ultra	0.0 (40.0)	180.0	2100.0	0.0
SteicoFlex	0.0 (150.0)	60.0	2100.0	0.0
Ampatex Sinco	0.0 (-)	280.0	850.0	0.0
Airspace, heat flow horizontal, 25 mm thick	25.0 (25.0)	1.2	1008.0	30996.0
Oriented strandboard (OSB)	11.0 (11.0)	650.0	1700.0	12155000.0
Gyproc Wallboard	12.5 (12.5)	0.0	0.0	0.0
Airspace, heat flow horizontal, 25 mm thick	25.0 (25.0)	1.2	1008.0	30240.0
Total				12216236.0
kappa value				12.2162
Limiting condition:	insulation			

Admittance : 1.06 W/m<sup>2</sup>K    Decrement : 0.53 factor    Decrement delay : -8.02 hours

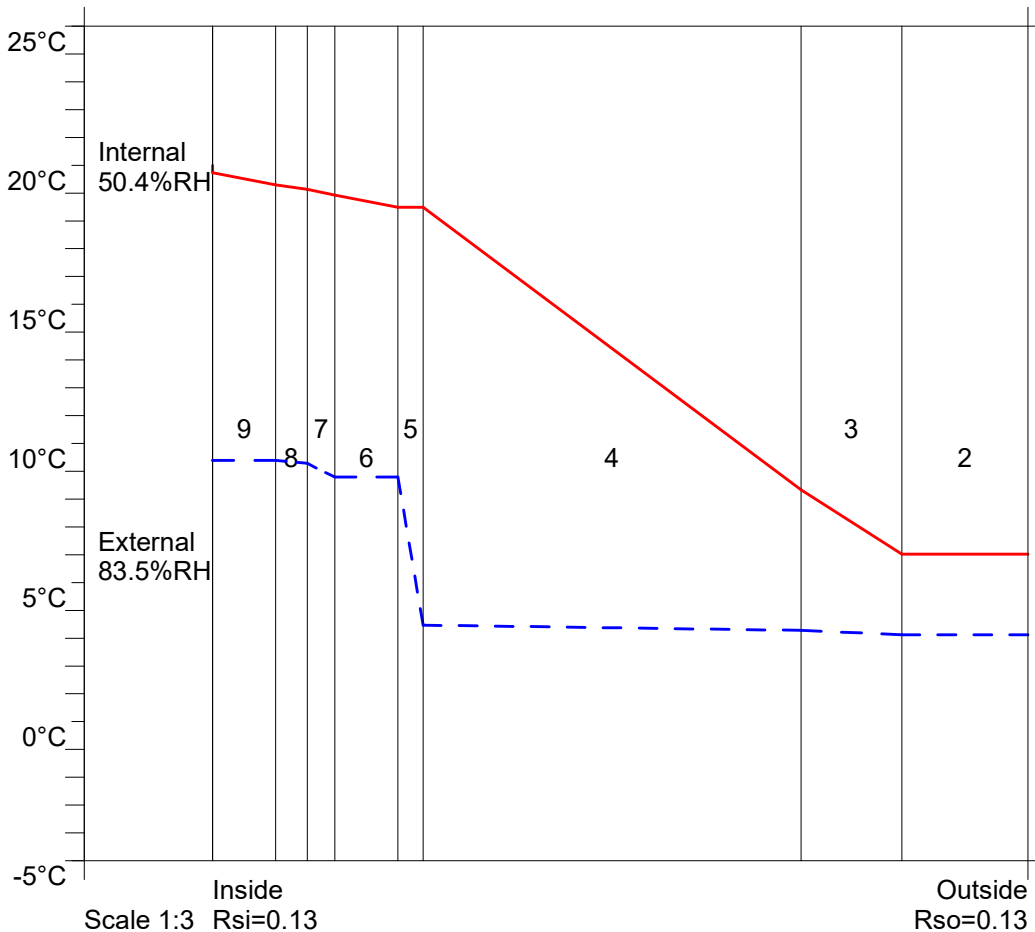
## Condensation Risk Analysis (no account taken of thermal bridges)

### 2 - Offices, Shops

Jan	Feb (worst)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0C 51.5%	20.0C 50.4%	20.0C 51.5%	20.0C 53.3%	20.0C 58.1%	20.0C 65.1%	20.0C 71.0%	20.0C 71.4%	20.0C 67.5%	20.0C 62.6%	20.0C 55.2%	20.0C 53.2%
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 Airspace, heat flow horizontal, 50 mm thick	6.0	3.1	0.76	0.94			No
3 Beltermo Ultra	6.0	3.1	0.76	0.94			No
4 SteicoFlex	8.3	3.3	0.77	1.10			No
5 Ampatex Sinco	18.5	3.5	0.78	2.13			No
6 Airspace, heat flow horizontal, 25 mm thick	18.5	8.8	1.13	2.13			No
7 Oriented strandboard (OSB)	18.9	8.8	1.13	2.19			No
8 Gyproc Wallboard	19.1	9.3	1.17	2.21			No
9 Airspace, heat flow horizontal, 25 mm thick	19.3	9.4	1.18	2.24			No
10 Inside surface resistance	19.7	9.4	1.18	2.30			No

Worst case internal / external conditions for graph : 20.0°C @ 50.4%RH / 5.7°C @ 83.5%RH



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

### 2 - Offices, Shops

Jan	Feb (worst)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0C 51.5%	20.0C 50.4%	20.0C 51.5%	20.0C 53.3%	20.0C 58.1%	20.0C 65.1%	20.0C 71.0%	20.0C 71.4%	20.0C 67.5%	20.0C 62.6%	20.0C 55.2%	20.0C 53.2%
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 Airspace, heat flow horizontal, 50 mm thick	16.2	12.8	1.47	1.84			No
3 Beltermo Ultra	16.2	12.8	1.47	1.84			No
4 SteicoFlex	16.8	12.8	1.48	1.91			No
5 Ampatex Sinco	19.6	12.8	1.48	2.28			No
6 Airspace, heat flow horizontal, 25 mm thick	19.6	14.4	1.64	2.28			No
7 Oriented strandboard (OSB)	19.7	14.4	1.64	2.29			No
8 Gyproc Wallboard	19.8	14.6	1.66	2.30			No
9 Airspace, heat flow horizontal, 25 mm thick	19.8	14.6	1.66	2.31			No
10 Inside surface resistance	19.9	14.6	1.66	2.33			No

Worst case internal / external conditions for graph : 20.0°C @ 71.0%RH / 16.1°C @ 80.5%RH

