**Back to Earth SW Ltd**
7 Tuns Lane
Silverton, Exeter
Devon. EX5 4HY

***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 (m²K/W) | Pitch (º) | Bridge details Air gaps (Level, Delta U") |
|---|---|---|---|---|---|
| Outside surface resistance | - | - | 0.100 | | |
| EPDM (ethylene propylene diene monomer) | 1.5 | 0.250 | 0.006 | | |
| Plywood (500 kg/m³) | 18.0 | 0.130 | 0.138 | | |
| Beltermo Ultra | 120.0 | 0.042 | 2.850 | | L:0 0.000W/m²K |
| SteicoFlex | 175.0 | 0.036 | 4.850 | | 9.000% Softwood (175.0mm) L:0 0.000W/m²K |
| Ampatex Variano | - | - | - | | |
| Airspace, heat flow upwards, 25 mm thick | 25.0 | - | 0.160 | | |
| Gyproc Wallboard | 12.5 | 0.189 | 0.066 | | |
| Inside surface resistance | - | - | 0.100 | | |
| **Total thickness** | **352.0mm** | | | | |

***U-value = 0.13W/m²K***

U-value, Combined Method : 0.132W/m²K (upper/lower limit 7.757 / 7.350m²K/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/m²K

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

| | Thickness (mm) | Thermal Conductivity (W/mK) | Thermal Resistance ($m^2K/W$) | Vapour Resistivity (MNs/gm) | Vapour Resistance (MNs/g) |
|---|---|---|---|---|---|
| Outside surface resistance | - | - | 0.100 | - | - |
| EPDM (ethylene propylene diene monomer) | 1.5 | 0.250 | 0.006 | 30000.00 | 45.00 |
| Plywood (500 kg/$m^3$) | 18.0 | 0.130 | 0.138 | 1000.00 | 18.00 |
| Beltermo Ultra | 120.0 | 0.042 | 2.850 | 15.00 | 1.80 |
| SteicoFlex | 175.0 | 0.036 | 4.850 | 5.00 | 0.88 |
| Ampatex Variano | - | - | - | - | 21.00 |
| 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 | - | - |
| **Total thickness** | **352.0mm** | | | | |

**Detailed U-value Calculation Results**

Construction includes 1 bridged layer

Non-bridged layers

| | |
|---|---|
| Outside surface resistance | 0.100 m²K/W |
| EPDM (ethylene propylene diene monomer) | 0.006 m²K/W |
| Plywood (500 kg/m³) | 0.138 m²K/W |
| Beltermo Ultra | 2.850 m²K/W |
| Airspace, heat flow upwards, 25 mm thick | 0.160 m²K/W |
| Gyproc Wallboard | 0.066 m²K/W |
| Inside surface resistance | 0.100 m²K/W |
| Resistance of non-bridged layers, $R_{NB}$ = | 3.420 m²K/W |

Bridged layer

SteicoFlex (L1) bridged by Softwood (B1)

Path 1 - SteicoFlex

Path 2 - Softwood

Resistance and fraction of heat flow paths

$R_{P1} = R_{NB} + R_{L1} = 3.420 + 4.850 = 8.270$ m²K/W $F_{P1} = 91.000\%$

$R_{P2} = R_{NB} + R_{L2} = 3.420 + 1.346 = 4.767$ m²K/W $F_{P2} = 9.000\%$

Upper resistance limit

$R_{upper} = 1 / ( (F_{P1}/R_{P1}) + (F_{P2}/R_{P2}) )$

$R_{upper} = 1 / ( (0.910/8.270) + (0.090/4.767) ) = 7.757$m²K/W

Lower resistance limit

$R_{lower} = R_{NB} + 1 / ((F_{L1}/R_{L1}) + (F_{B1}/R_{B1}))$

$R_{lower} = 3.420 + 1 / ((0.910/4.850) + (0.090/1.346)) = 7.350$m²K/W

Total resistance of roof

$R_T = ( R_{upper} + R_{lower} ) / 2 = (7.757 + 7.350) / 2 = 7.55$ m²K/W

Correction for air gaps, Delta Ug = 0.0000W/m²K

(Delta Uf + Delta Ug + Delta Up + Delta Ur) is less than 3% of (1 / Rt) so U = (1 / Rt) + (Delta Ur) + (Delta Urc) = 0.13 W/m²K

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

**Condensation is occuring at the following layers interfaces:-**
Interface 1 : Plywood (500 kg/m³) / Beltermo Ultra

| Month | Int (C°) | Int (%RH) | Ext (C°) | Ext (%RH) | Interface 1 Gc (Kg/m²) | Ma (Kg/m²) |
|---|---|---|---|---|---|---|
| Jan | 21.00 | 56.10 | 5.90 | 85.50 | 0.04571 | 0.12351 |
| Feb | 21.00 | 55.20 | 5.70 | 83.50 | 0.04032 | 0.16383 |
| Mar | 21.00 | 55.50 | 6.90 | 82.00 | 0.03681 | 0.20064 |
| Apr | 21.00 | 56.20 | 8.80 | 79.50 | 0.02298 | 0.22362 |
| May | 21.00 | 59.30 | 11.50 | 79.00 | -0.00302 | 0.22060 |
| Jun | 21.00 | 64.30 | 14.30 | 79.50 | -0.02014 | 0.20046 |
| Jul | 21.00 | 68.80 | 16.10 | 80.50 | -0.03085 | 0.16961 |
| Aug | 21.00 | 69.30 | 16.00 | 81.50 | -0.02737 | 0.14224 |
| Sep | 21.00 | 66.60 | 14.30 | 83.00 | -0.01169 | 0.13055 |
| Oct | 21.00 | 63.20 | 11.90 | 85.00 | 0.00696 | 0.00696 |
| Nov | 21.00 | 58.20 | 8.50 | 84.50 | 0.03067 | 0.03764 |
| Dec | 21.00 | 57.00 | 7.00 | 85.50 | 0.04017 | 0.07780 |

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) = 0.22362 Kg/m²

Annual moisture accumulation = 0.13055 Kg/m²

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***Thermal Mass Details***

| | Thickness assessed (actual) (mm) | Density (kg/m³) | Specific heat capacity (J/kgK) | Heat capacity (kJ/m²K) |
|---|---|---|---|---|
| EPDM (ethylene propylene diene monomer) | 0.0 (1.5) | 1150.0 | 1000.0 | 0.0 |
| Plywood (500 kg/m³) | 0.0 (18.0) | 500.0 | 1600.0 | 0.0 |
| Beltermo Ultra | 0.0 (120.0) | 180.0 | 2100.0 | 0.0 |
| SteicoFlex | 0.0 (175.0) | 60.0 | 2100.0 | 0.0 |
| Ampatex Variano | 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 : 1.08 W/m²K Decrement : 0.14 factor Decrement delay : -14.86 hours

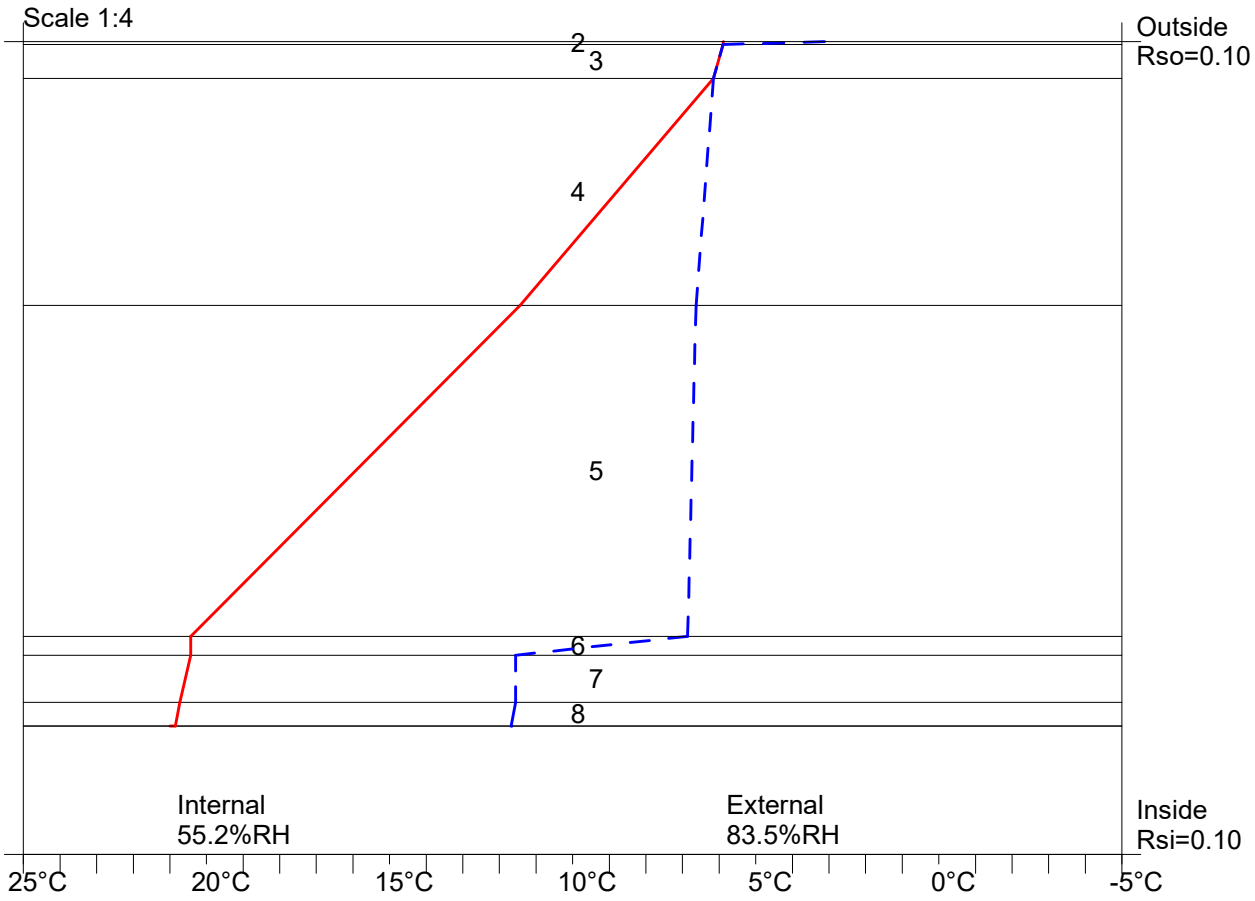
**Condensation Risk Analysis (no account taken of thermal bridges)**

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. ºC | Dewpoint Temp. ºC | Vapour Pressure (kPa) | Saturated V.P. (kPa) | Worst Cond. (g/m²) | Peak Buildup (g/m²) | Conden-sation |
|---|---|---|---|---|---|---|---|
| 1 Outside surface resistance | 5.9 | 3.1 | 0.76 | 0.93 | | | No |
| 2 EPDM (ethylene propylene diene monomer) | 5.9 | 5.9 | 0.93 | 0.93 | | | No |
| 3 Plywood (500 kg/m³) | 6.2 | 6.2 | 0.94 | 0.94 | 46 in Jan | 224 in Apr | Yes |
| 4 Beltermo Ultra | 11.4 | 6.6 | 0.98 | 1.35 | | | No |
| 5 SteicoFlex | 20.4 | 6.9 | 0.99 | 2.40 | | | No |
| 6 Ampatex Variano | 20.4 | 11.6 | 1.36 | 2.40 | | | No |
| 7 Airspace, heat flow upwards, 25 mm thick | 20.7 | 11.6 | 1.36 | 2.44 | | | No |
| 8 Gyproc Wallboard | 20.8 | 11.7 | 1.37 | 2.46 | | | No |
| 9 Inside surface resistance | | | | | | | |

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










Calculations are based on manufacturers information and for default structures.

**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. ºC | Dewpoint Temp. ºC | Vapour Pressure (kPa) | Saturated V.P. (kPa) | Worst Cond. (g/m²) | Peak Buildup (g/m²) | Conden-sation |
|---|---|---|---|---|---|---|---|
| 1 Outside surface resistance | 16.2 | 12.8 | 1.47 | 1.84 | | | No |
| 2 EPDM (ethylene propylene diene monomer) | 16.2 | 14.0 | 1.59 | 1.84 | | | No |
| 3 Plywood (500 kg/m³) | 16.2 | 14.5 | 1.64 | 1.85 | 46 in Jan | 224 in Apr | Yes |
| 4 Beltermo Ultra | 17.9 | 14.5 | 1.65 | 2.05 | | | No |
| 5 SteicoFlex | 20.8 | 14.5 | 1.65 | 2.46 | | | No |
| 6 Ampatex Variano | 20.8 | 15.1 | 1.71 | 2.46 | | | No |
| 7 Airspace, heat flow upwards, 25 mm thick | 20.9 | 15.1 | 1.71 | 2.47 | | | No |
| 8 Gyproc Wallboard | 21.0 | 15.1 | 1.71 | 2.48 | | | No |
| 9 Inside surface resistance | | | | | | | |

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