Back to Earth SW Ltd
7 Tuns Lane
Silverton
Exeter
EX5 4HY

Project Information
Reference
Date 17 November 2023

Construction Type
Element : Pitched roof, ceiling at rafter line - Roof-pitched-over- 150mm
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	-	-	0.040		
Ampatop Protecta	-	-	-		
Beltermo Ultra	80.0	0.042	1.900		L:0 0.000W/m²K
UdiTHERM	80.0	0.038	2.100		L:0 0.000W/m²K
SteicoFlex	150.0	0.036	4.150		9.000% Softwood (150.0mm) L:0 0.000W/m²K
Oriented strandboard (OSB)	9.0	0.130	0.069		
Ampatex Sinco	-	-	-		
Airspace, heat flow upwards, 25 mm thick	25.0	-	0.160		11.800% Softwood (25.0mm)
Gyproc Wallboard	12.5	0.190	0.066		
Inside surface resistance	-	-	0.100		
Total thickness	**356.5mm**				

U-value = 0.13W/m²K

U-value, Combined Method : 0.129W/m²K (upper/lower limit 8.194 / 7.802m²K/W, dUf 0.0045, 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 m² Af : 12.500mm² Recess : 0.0mm
Delta Uf for Beltermo Ultra : 0.0021
Warm pitched roof - insulation over rafters
Alpha : 0.80 per m lambda f : 50.0000W/mK nf : 6.700 per m² Af : 12.000mm² Recess : 0.0mm
Delta Uf for UdiTHERM : 0.0024
nf = fasteners per m² Af = fasteners cross-sectional area
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 (m²K/W)	Vapour Resistivity (MNs/gm)	Vapour Resistance (MNs/g)
Outside surface resistance	-	-	0.040	-	-
Ampatop Protecta	-	-	-	-	0.50
Beltermo Ultra	80.0	0.042	1.900	15.00	1.20
UdiTHERM	80.0	0.038	2.100	25.00	2.00
SteicoFlex	150.0	0.036	4.150	5.00	0.75
Oriented strandboard (OSB)	9.0	0.130	0.069	250.00	2.25
Ampatex Sinco	-	-	-	-	25.00
Airspace, heat flow upwards, 25 mm thick	25.0	-	0.160	-	0.00
Gyproc Wallboard	12.5	0.190	0.066	50.00	0.63
Inside surface resistance	-	-	0.100	-	-
Total thickness	**356.5mm**				

Detailed U-value Calculation Results

Construction includes 2 bridged layers

Non-bridged layers

Outside surface resistance	0.040 m²K/W
Beltermo Ultra	1.900 m²K/W
UdiTHERM	2.100 m²K/W
Oriented strandboard (OSB)	0.069 m²K/W
Gyproc Wallboard	0.066 m²K/W
Inside surface resistance	0.100 m²K/W
Resistance of non-bridged layers, R_{NB} =	4.275 m²K/W

Bridged layers

SteicoFlex (L1) bridged by Softwood (B1)

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

Path 1 - SteicoFlex
Path 2 - Softwood /
Path 3 - SteicoFlex
Path 4 - Softwood /

Resistance and fraction of heat flow paths

$R_{P1} = R_{NB} + R_{L1} = 4.275 + 4.310 = 8.585$ m²K/W $F_{P1} = 80.262\%$
$R_{P2} = R_{NB} + R_{L2} = 4.275 + 1.314 = 5.589$ m²K/W $F_{P2} = 7.938\%$
$R_{P3} = R_{NB} + R_{L3} = 4.275 + 4.342 = 8.618$ m²K/W $F_{P3} = 10.738\%$
$R_{P4} = R_{NB} + R_{L4} = 4.275 + 1.346 = 5.621$ m²K/W $F_{P4} = 1.062\%$

Upper resistance limit

$R_{upper} = 1 / ((F_{P1}/R_{P1}) + (F_{P2}/R_{P2}) + (F_{P3}/R_{P3}) + (F_{P4}/R_{P4}))$
$R_{upper} = 1 / ((0.803/8.585) + (0.079/5.589) + (0.107/8.618) + (0.011/5.621)) = 8.194$m²K/W

Lower resistance limit

$R_{lower} = R_{NB} + 1 / ((F_{L1}/R_{L1}) + (F_{B1}/R_{B1})) + 1 / ((F_{L2}/R_{L2}) + (F_{B2}/R_{B2}))$
$R_{lower} = 4.275 + 1 / ((0.910/4.150) + (0.090/1.154)) + 1 / ((0.882/0.160) + (0.118/0.192)) = 7.802$m²K/W

Total resistance of roof

$R_T = (R_{upper} + R_{lower}) / 2 = (8.194 + 7.802) / 2 = 8.00$ m²K/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 m² Af : 12.500mm² Recess : 0.0mm
Delta Uf for Beltermo Ultra : 0.0021
Warm pitched roof - insulation over rafters
Alpha : 0.80 per m lambda f : 50.0000W/mK nf : 6.700 per m² Af : 12.000mm² Recess : 0.0mm
Delta Uf for UdiTHERM : 0.0024
Correction for air gaps, Delta Ug = 0.0000W/m²K

U = (1 / Rt) + (Delta Uf + Delta Ug + Delta Up + Delta Urc2 + Delta Urc2) = (1/7.9981) + 0.0045 + 0.0000 + 0.0000 + 0.0000 + 0.0000 = 0.13 W/m²K

Structure element : Pitched roof, ceiling at rafter line
Condensation calculations performed in accordance with BS5250:2021

Condensation is occuring at the following layers interfaces:-

Month	Int (C°)	Int (%RH)	Ext (C°)	Ext (%RH)
Jan	21.00	45.10	3.10	85.00
Feb	21.00	44.60	3.10	83.50
Mar	21.00	45.40	5.20	79.50
Apr	21.00	46.70	7.60	75.50
May	21.00	51.40	10.60	76.00
Jun	21.00	57.20	14.00	74.50
Jul	21.00	61.90	15.80	75.00
Aug	21.00	62.60	15.40	77.50
Sep	21.00	58.60	13.20	79.50
Oct	21.00	53.90	10.00	83.00
Nov	21.00	48.00	6.00	84.00
Dec	21.00	46.40	4.20	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/m²

Annual moisture accumulation = 0.00000 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)
Ampatop Protecta	0.0 (-)	300.0	850.0	0.0
Beltermo Ultra	0.0 (80.0)	180.0	2100.0	0.0
UdiTHERM	0.0 (80.0)	140.0	2100.0	0.0
SteicoFlex	0.0 (150.0)	60.0	2100.0	0.0
Oriented strandboard (OSB)	9.0 (9.0)	650.0	1700.0	9945000.0
Ampatex Sinco	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)	0.0	0.0	0.0
Total				9975240.0
kappa value				9.9752

Limiting condition: insulation

Admittance : 1.02 W/m²K Decrement : 0.12 factor Decrement delay : -15.36 hours

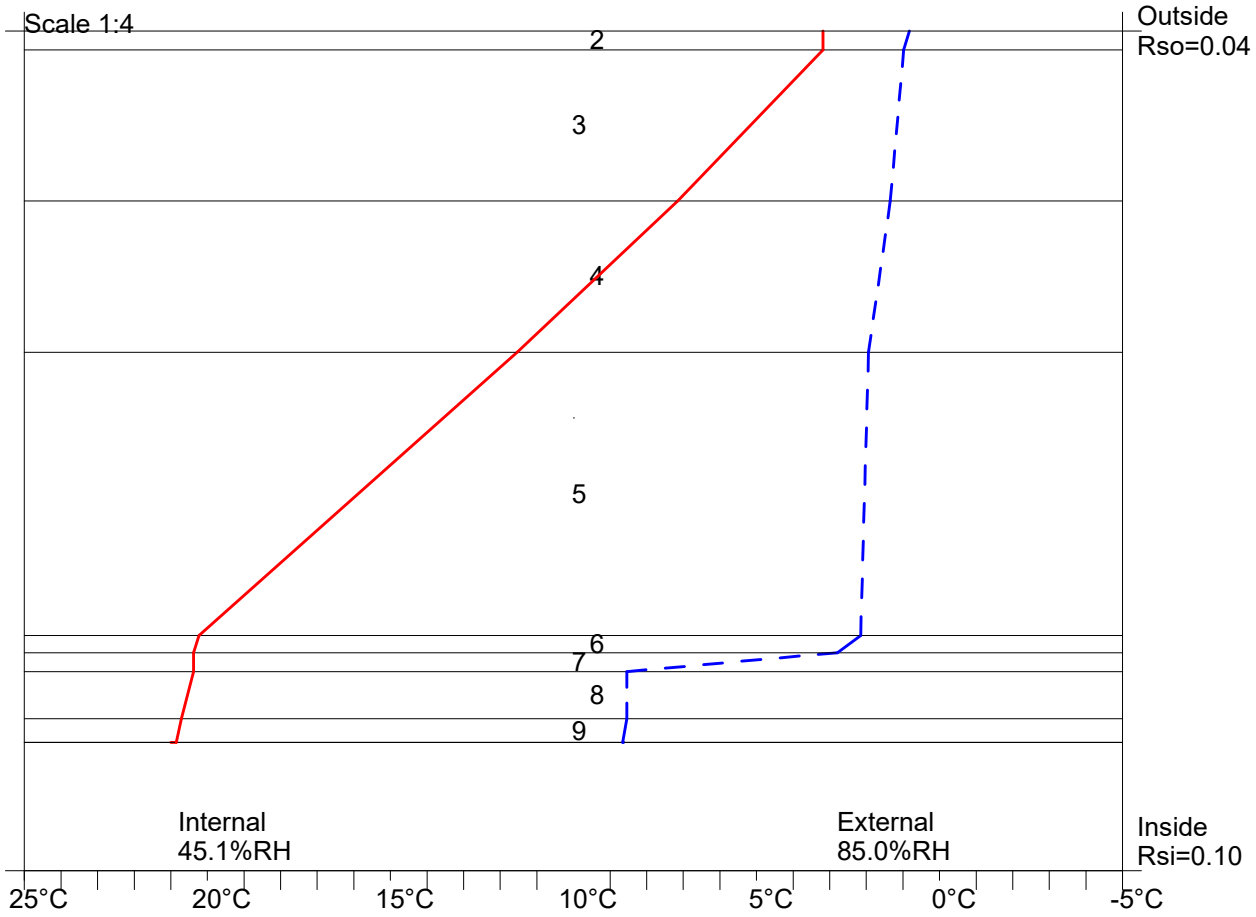
Condensation Risk Analysis (no account taken of thermal bridges)

2 - Offices, shops and dwellings with low occupancy

Jan (worst)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.0C 45.1%	21.0C 44.6%	21.0C 45.4%	21.0C 46.7%	21.0C 51.4%	21.0C 57.2%	21.0C 61.9%	21.0C 62.6%	21.0C 58.6%	21.0C 53.9%	21.0C 48.0%	21.0C 46.4%
3.1C 85.0%	3.1C 83.5%	5.2C 79.5%	7.6C 75.5%	10.6C 76.0%	14.0C 74.5%	15.8C 75.0%	15.4C 77.5%	13.2C 79.5%	10.0C 83.0%	6.0C 84.0%	4.2C 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	3.2	0.8	0.65	0.77			No
2 Ampatop Protecta	3.2	1.0	0.66	0.77			No
3 Beltermo Ultra	7.2	1.3	0.67	1.01			No
4 UdiTHERM	11.5	1.9	0.70	1.36			No
5 SteicoFlex	20.2	2.2	0.71	2.37			No
6 Oriented strandboard (OSB)	20.4	2.8	0.75	2.39			No
7 Ampatex Sinco	20.4	8.5	1.11	2.39			No
8 Airspace, heat flow upwards, 25 mm thick	20.7	8.5	1.11	2.44			No
9 Gyproc Wallboard	20.8	8.7	1.12	2.46			No
10 Inside surface resistance							

Worst case internal / external conditions for graph : 21.0°C @ 45.1%RH / 3.1°C @ 85.0%RH



Condensation Risk Analysis (no account taken of thermal bridges)

2 - Offices, shops and dwellings with low occupancy

Jan (worst)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.0C 45.1%	21.0C 44.6%	21.0C 45.4%	21.0C 46.7%	21.0C 51.4%	21.0C 57.2%	21.0C 61.9%	21.0C 62.6%	21.0C 58.6%	21.0C 53.9%	21.0C 48.0%	21.0C 46.4%
3.1C 85.0%	3.1C 83.5%	5.2C 79.5%	7.6C 75.5%	10.6C 76.0%	14.0C 74.5%	15.8C 75.0%	15.4C 77.5%	13.2C 79.5%	10.0C 83.0%	6.0C 84.0%	4.2C 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	15.8	11.4	1.35	1.80			No
2 Ampatop Protecta	15.8	11.4	1.35	1.80			No
3 Beltermo Ultra	17.0	11.5	1.36	1.93			No
4 UdiTHERM	18.3	11.6	1.37	2.10			No
5 SteicoFlex	20.8	11.7	1.37	2.45			No
6 Oriented strandboard (OSB)	20.8	11.8	1.39	2.46			No
7 Ampatex Sinco	20.8	13.4	1.53	2.46			No
8 Airspace, heat flow upwards, 25 mm thick	20.9	13.4	1.53	2.47			No
9 Gyproc Wallboard	21.0	13.4	1.54	2.48			No
10 Inside surface resistance							

Worst case internal / external conditions for graph : 21.0°C @ 61.9%RH / 15.8°C @ 75.0%RH