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-under-50mm
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	-	-	-		
SteicoFlex	50.0	0.036	1.350		9.000% Softwood (50.0mm) L:0 0.000W/m²K
Beltermo Ultra	120.0	0.042	2.850		L:0 0.000W/m²K
Ampatex Sinco	-	-	-		
SteicoFlex	25.0	0.036	0.650		11.800% Softwood (25.0mm) L:0 0.000W/m²K
Gyproc Wallboard	12.5	0.190	0.066		
Inside surface resistance	-	-	0.100		
Total thickness	**207.5mm**				

U-value = 0.22W/m²K

U-value, Combined Method : 0.218W/m²K (upper/lower limit 4.892 / 4.665m²K/W, dUf 0.0089, 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 : 0.0089
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
SteicoFlex	50.0	0.036	1.350	5.00	0.25
Beltermo Ultra	120.0	0.042	2.850	15.00	1.80
Ampatex Sinco	-	-	-	-	25.00
SteicoFlex	25.0	0.036	0.650	5.00	0.13
Gyproc Wallboard	12.5	0.190	0.066	50.00	0.63
Inside surface resistance	-	-	0.100	-	-
Total thickness	**207.5mm**				

Detailed U-value Calculation Results

Construction includes 2 bridged layers

Non-bridged layers

Outside surface resistance	0.040 m²K/W
Beltermo Ultra	2.850 m²K/W
Gyproc Wallboard	0.066 m²K/W
Inside surface resistance	0.100 m²K/W
Resistance of non-bridged layers, R_{NB} =	3.056 m²K/W

Bridged layers

SteicoFlex (L1) bridged by Softwood (B1)
SteicoFlex (L2) bridged by Softwood (B2)

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

Resistance and fraction of heat flow paths

$R_{P1} = R_{NB} + R_{L1} = 3.056 + 2.000 = 5.056$ m²K/W $F_{P1} = 80.262\%$
$R_{P2} = R_{NB} + R_{L2} = 3.056 + 1.035 = 4.091$ m²K/W $F_{P2} = 7.938\%$
$R_{P3} = R_{NB} + R_{L3} = 3.056 + 1.542 = 4.598$ m²K/W $F_{P3} = 10.738\%$
$R_{P4} = R_{NB} + R_{L4} = 3.056 + 0.577 = 3.633$ m²K/W $F_{P4} = 1.062\%$

Upper resistance limit

$R_{upper} = 1 / ((F_{P1}/R_{P1}) + (F_{P2}/R_{P2}) + (F_{P3}/R_{P3}) + (F_{P4}/R_{P4}))$
$R_{upper} = 1 / ((0.803/5.056) + (0.079/4.091) + (0.107/4.598) + (0.011/3.633)) = 4.892$m²K/W

Lower resistance limit

$R_{lower} = R_{NB} + 1 / ((F_{L1}/R_{L1}) + (F_{B1}/R_{B1})) + 1 / ((F_{L2}/R_{L2}) + (F_{B2}/R_{B2}))$
$R_{lower} = 3.056 + 1 / ((0.910/1.350) + (0.090/0.385)) + 1 / ((0.882/0.650) + (0.118/0.192)) = 4.665$m²K/W

Total resistance of roof

$R_T = (R_{upper} + R_{lower}) / 2 = (4.892 + 4.665) / 2 = 4.78$ 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 : 0.0089
Correction for air gaps, Delta Ug = 0.0000W/m²K

U = (1 / Rt) + (Delta Uf + Delta Ug + Delta Up + Delta Urc2 + Delta Urc2) = (1/4.7782) + 0.0089 + 0.0000 + 0.0000 + 0.0000 + 0.0000 = 0.22 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
SteicoFlex	0.0 (50.0)	60.0	2100.0	0.0
Beltermo Ultra	0.0 (120.0)	180.0	2100.0	0.0
Ampatex Sinco	0.0 (-)	280.0	850.0	0.0
SteicoFlex	0.0 (25.0)	60.0	2100.0	0.0
Gyproc Wallboard	12.5 (12.5)	0.0	0.0	0.0
Total				0.0
kappa value				0.0000
Limiting condition:	insulation			

Admittance : 0.72 W/m²K Decrement : 0.29 factor Decrement delay : -9.50 hours

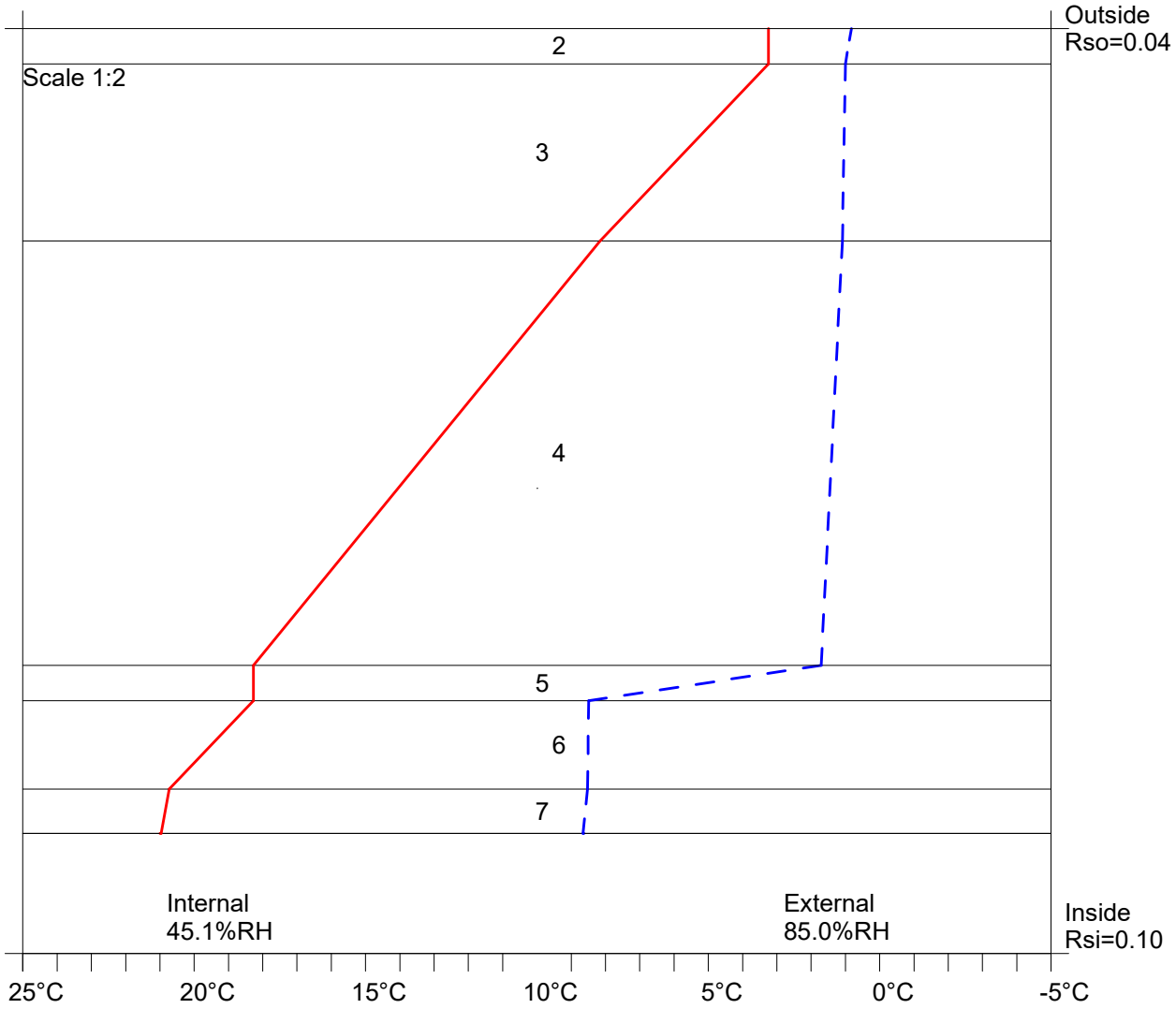
Condensation Risk Analysis (no account taken of thermal bridges)

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 SteicoFlex	8.2	1.1	0.66	1.08			No
4 Beltermo Ultra	18.3	1.7	0.69	2.10			No
5 Ampatex Sinco	18.3	8.5	1.11	2.10			No
6 SteicoFlex	20.7	8.5	1.11	2.44			No
7 Gyproc Wallboard	21.0	8.7	1.12	2.48			No
8 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)

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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 SteicoFlex	17.3	11.4	1.35	1.97			No
4 Beltermo Ultra	20.2	11.6	1.36	2.37			No
5 Ampatex Sinco	20.2	13.4	1.53	2.37			No
6 SteicoFlex	20.9	13.4	1.53	2.47			No
7 Gyproc Wallboard	21.0	13.4	1.54	2.48			No
8 Inside surface resistance							

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