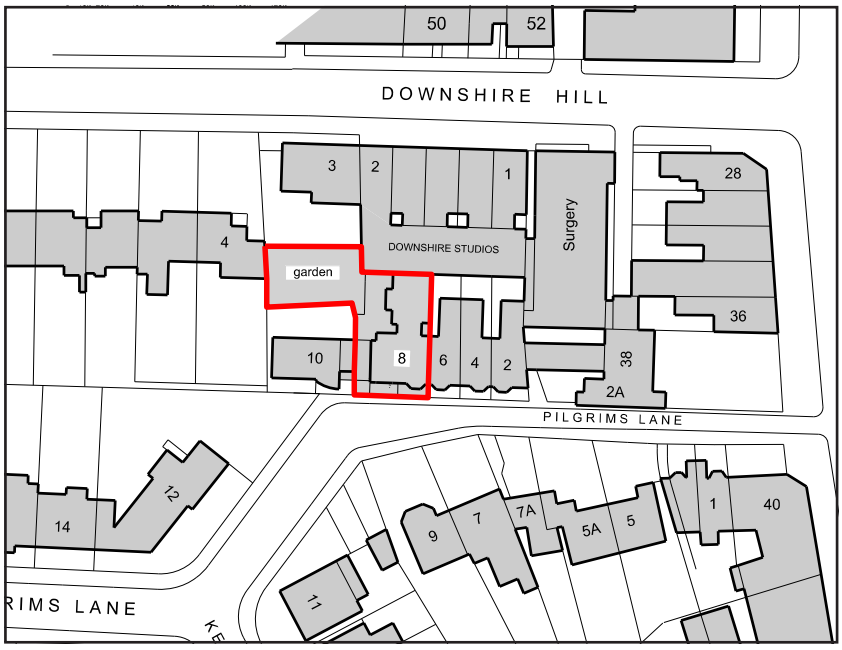
101-103 Heath Street
London
NW3 6SS

Cooling Hierarchy & Thermal Calculations for Installation of Air Conditioning unit

8 Pilgrim's Lane
July 2020



Introduction

1. This Cooling Hierarchy and thermal calculations was requested by the Camden Planning Officer Charlotte Meynell and accompanies and supports the application for the installation of a single Air Conditioning Unit at 8 Pilgrim's Lane under the application:

2020/2666/P
Erection of single storey outbuilding in rear garden, to house 1 x new air conditioning unit and associated acoustic enclosure.

2. The proposal involves placing a timber boarded housing with the appearance of a garden store. Contained within is an attenuated enclosure surrounding a single Air Conditioning Unit. The housing is surrounded by a hedge concealing views of the timber enclosure.

3. The house is in an Arts and Crafts style built between 1870 to 1890. It is of solid brick construction with 330mm solid brick walls, it has no insulation internally and the roof is uninsulated. The house is being entirely refurbished with a new basement extension (already constructed). Prior to this refurbishment it had not undergone any significant upgrade since it's construction.

4. It is intended to provide Air Conditioning to 4 bedrooms and principal reception rooms including the Kitchen, Dining Room, Lounge, Ballroom and Basement. The substantial upgrade of the fabric of the building will include insulated drylining of almost all external brick walls, the insulation of all roof areas to meet and exceed Building Regulation requirements amongst other improvements defined below. The section below will demonstrate what steps have been taken to ensure that all measures have been taken prior to considering Air Conditioning and to offset the energy require-ments of the Air Conditioning under Policy CC2 of the Camden Local Plan.

Cooling Hierarchy.

To be read with Thermal Calculations Appendix

1. Minimise internal heat generation through energy efficient design.

Energy generation will be limited by the following upgrades by the following methods:

a. All lighting will be LED and controlled by smart lighting system controls
b. A new energy efficient boiler will provide heating in combination with an underfloor heating system with timber floors.
c. Heating control will be managed intelligently and remotely using an intelligent system to remember routine energy use to set up heating preferences automatically
d. Ability to avoid wasting energy by not heating unused rooms and providing information about how much energy your heating system is using.
e. Heating compensation to adjust the boiler output temperature depending on the temperature in your home or outside
f. Installation of a smart electricity meter to provide accurate and real-time information about energy use, enabling informed decisions about energy management.

2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;

a. The house is in a Conservation Area and the orientation is fixed. It is therefore not possible to shade the windows externally. There is current application for the replacement of all single glazed windows which are extremely dilapidated with double glazed. These will reduce heat gains in the summer and dramatically prevent energy loss in the winter. They will also prevent coolth of Air Conditioning escaping. Almost all external walls be insulated internally which will dramatically reduce heat loss. Internal blinds and curtains will also reduce heat gain.

3. Manage the heat within the building through exposed internal thermal mass and high ceilings

It is considered that the insulation of the internal walls will have greater benefit in the winter for internal heat loss rather than exposing thermal mass. The high ceilings will be of some benefit.

4. Windows are openable however during the hottest summer period it is not felt that this is sufficient to create a comfortable temperature

5. Mechanical ventilation.

It is not felt that mechanical ventilation would be of benefit and would not be an energy efficient strategy.

6.Active Cooling.

It is intended that Air conditioning will be used during the increasing periods of very warm weather which was experience last summer 2019 and its incorporation now rather than in the future will reduce further works and upgrades in the future.

Conclusion

From the points outlined we believe that the above energy savings made throughout the house will will offset the energy requirement of this single AC unit which will be of great benefit to the users

Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Pitched or mansard roof, ceiling at line of pitch
Description : Pitched roof - Ventilated
File reference : 1K177R6A69.FCF

Calculated 'U' value = 0.16W/m²K (Calculated in accordance with BS EN ISO 6946:2017)

Element Description	Element Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)	Vapour Resistivity (MNs/gm)	Vapour Resistance (MNs/g)	Mean T (K)	Delta T (K)
Outside surface resistance	-	-	0.172	-	-	80.84	0.27
TILES / SLATES ON BATTENS ; PITCHED ROOF.	30.0	0.000	0.000	0.00	0.00	80.98	0.00
VENTILATED RAFTER CAVITY	50.0	-	0.000	-	0.00	80.98	0.00
KOOLTHERM K7 BETWEEN TIMBER RAFTERS 12.7% roof timber - 47mm @ 400mm ctrs + 1% for noggins + loft hatches (100.0mm)	100.0	0.020	5.000	-	44.95	84.94	7.92
KOOLTHERM K118 (12.5mm plasterboard internal finish)	57.5	-	2.566	-	102.10	90.93	4.06
PLASTER SKIM	3.0	0.180	0.017	60.00	0.18	92.98	0.03
Inside surface resistance	-	-	0.100	-	-	93.07	0.16

Detailed U-value Calculation Results

Construction includes 1 bridged layer.

Non-bridged layers

Outside surface resistance	0.172 m²K/W
KOOLTHERM K118 (12.5mm plasterboard internal finish)	2.566 m²K/W
PLASTER SKIM	0.017 m²K/W
Inside surface resistance	0.100 m²K/W
Resistance of non-bridged layers, R_{NB}=	2.855 m²K/W

Detailed U-value Calculation Results (continued)

Resistance of heat flow paths

R_{P1} = R_{NB} + R_{L1} = 2.855 + 5.000 = 7.855 m²K/W F_{P1} = 87.251%

R_{P2} = R_{NB} + R_{L2} = 2.855 + 0.769 = 3.624 m²K/W F_{P2} = 12.749%

Fraction of face area of materials

KOOLTHERM K7 BETWEEN TIMBER RAFTERS, F_{L1} = 87.3%

roof timber - 47mm @ 400mm ctrs + 1% for noggins + loft hatches, F_{B1} = 12.7%

Upper resistance limit

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

R_{upper} = 1 / ((0.873/7.855) + (0.127/3.624)) = 6.837m²K/W

Lower resistance limit

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

R_{lower} = 2.855 + 1 / ((0.8725/5.0000) + (0.1275/0.7692)) = 5.794 m²K/W

Total resistance of roof

$R_T = (R_{upper} + R_{lower}) / 2$ = (6.837 + 5.794) / 2 = 6.316 m²K/W

(Correction for mechanical fasteners, Delta Uf = 0.0000W/m²K | Correction for air gaps, Delta Ug = 0.0000W/m²K)
(Alpha 0.0 m^{-1} | Fasteners per square metre 0.0000)
(Fasteners cross-sectional area 0.000 mm² | Thermal conductivity of fastener 0.00 W/mK)

(Delta Uf + Delta Ug) is less than 3% of (1 / Rt) so U = (1 / Rt) = 0.16W/m²K

For further information on the specified products, e.g. literature or specification clauses, please follows the links below:-

Kooltherm K7

KOOLTHERM K118

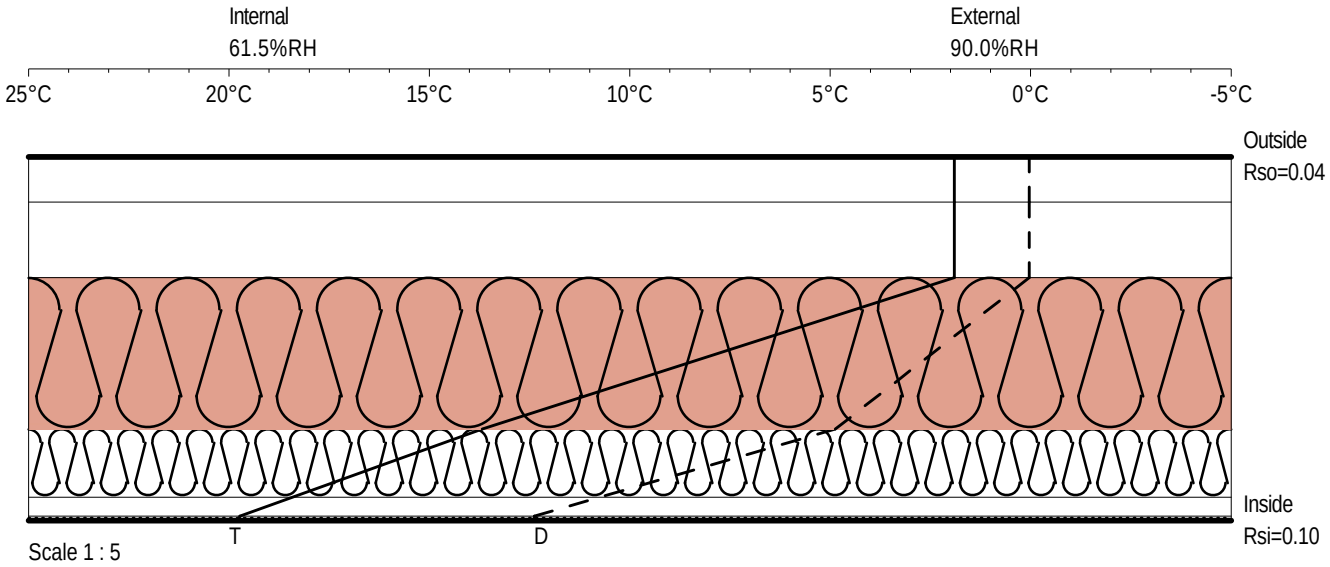
Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Pitched or mansard roof, ceiling at line of pitch
Description : Pitched roof - Ventilated
File reference : 1K177R6A69.FCF
Humidity Class: 3 - Dwellings with low occupancy
Location: 5a England SE & Central South

Condensation calculations performed in accordance with BS5250: 2011

Month	Int (°C)	Int (%RH)	Ext (°C)	Ext (%RH)
Jan	20.0	61.5	1.5	90.0
Feb	20.0	60.4	1.8	86.5
Mar	20.0	59.7	3.7	84.0
Apr	20.0	59.1	6.0	81.0
May	20.0	61.0	9.3	81.0
Jun	20.0	63.8	12.4	80.0
Jul	20.0	67.3	14.5	80.5
Aug	20.0	68.0	14.1	82.5
Sep	20.0	66.2	11.8	85.5
Oct	20.0	63.9	8.7	88.0
Nov	20.0	61.8	4.4	89.5
Dec	20.0	61.7	2.5	90.5

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) = 0.00 Kg/m²
Annual moisture accumulation (Ma) = 0.00 Kg/m²



Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Wall
Description : Insulated dry lining - mechanically fastened
File reference : 1K177R6C99.FCF

Calculated 'U' value = 0.49W/m²K (Calculated in accordance with BS EN ISO 6946:2017)

Element Description	Element Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)	Vapour Resistivity (MNs/gm)	Vapour Resistance (MNs/g)	Mean T (K)	Delta T (K)
Outside surface resistance	-	-	0.040	-	-	80.81	0.21
BRICKWORK FACING	300.0	0.770	0.390	42.00	12.60	81.94	2.04
METAL LINING CAVITY; U/V. 0.3% wall - 1.2mm steel @ 600mm ctrs + 1.2mm @ 1200mm ctrs (25.0mm)	25.0	-	0.644	-	0.05	84.64	3.36
KOOLTHERM K118 (12.5mm plasterboard internal finish)	32.5	-	1.177	-	94.70	89.39	6.15
Inside surface resistance	-	-	0.130	-	-	92.81	0.68

Detailed U-value Calculation Results

Construction includes 2 bridged layers.

Non-bridged layers

Outside surface resistance	0.040 m²K/W
BRICKWORK FACING	0.390 m²K/W
KOOLTHERM K118 (12.5mm plasterboard internal finish)	1.177 m²K/W
Inside surface resistance	0.130 m²K/W
Resistance of non-bridged layers, R_{NB}=	1.737 m²K/W

Detailed U-value Calculation Results (continued)

Resistance of heat flow paths

R_{P1} = R_{NB} + R_{L1} = 1.737 + 0.644 = 2.380 m²K/W F_{P1} = 99.700%

R_{P2} = R_{NB} + R_{L2} = 1.737 + 0.001 = 1.737 m²K/W F_{P2} = 0.300%

Fraction of face area of materials

METAL LINING CAVITY; U/V., F_{L1} = 99.7%

wall - 1.2mm steel @ 600mm ctrs + 1.2mm @ 1200mm ctrs, F_{B1} = 0.3%

Upper resistance limit

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

R_{upper} = 1 / ((0.997/2.380) + (0.003/1.737)) = 2.377m²K/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} = 1.737 + 1 / ((0.9970/0.6435) + (0.0030/0.0005)) + 1 / ((0.0000/0.0000) + (1.0000/0.0000)) = 1.869 m²K/W

Total resistance of wall

$R_T = (R_{upper} + R_{lower}) / 2$ = (2.377 + 1.869) / 2 = 2.123 m²K/W

(Correction for mechanical fasteners, Delta Uf = 0.0201W/m²K | Correction for air gaps, Delta Ug = 0.0000W/m²K)
(Alpha 0.8 m^{-1} | Fasteners per square metre 16.7000)
(Fasteners cross-sectional area 4.000 mm² | Thermal conductivity of fastener 50.00 W/mK)

U = (1 / Rt) + (Delta Uf + Delta Ug) = (1/2.123) + 0.0201 + 0.0000 = 0.49W/m²K

For further information on the specified products, e.g. literature or specification clauses, please follows the links below:-

KOOLTHERM K118

Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Wall
Description : Insulated dry lining - mechanically fastened
File reference : 1K177R6C99.FCF
Humidity Class: 3 - Dwellings with low occupancy
Location: 5a England SE & Central South

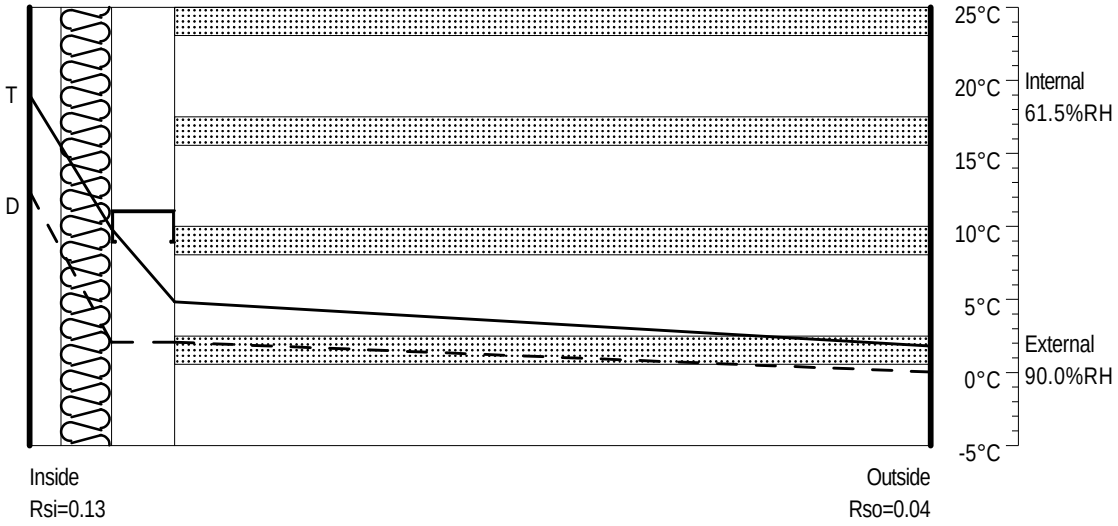
Condensation calculations performed in accordance with BS5250: 2011

Month	Int (°C)	Int (%RH)	Ext (°C)	Ext (%RH)
Jan	20.0	61.5	1.5	90.0
Feb	20.0	60.4	1.8	86.5
Mar	20.0	59.7	3.7	84.0
Apr	20.0	59.1	6.0	81.0
May	20.0	61.0	9.3	81.0
Jun	20.0	63.8	12.4	80.0
Jul	20.0	67.3	14.5	80.5
Aug	20.0	68.0	14.1	82.5
Sep	20.0	66.2	11.8	85.5
Oct	20.0	63.9	8.7	88.0
Nov	20.0	61.8	4.4	89.5
Dec	20.0	61.7	2.5	90.5

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) = 0.00 Kg/m²
Annual moisture accumulation (Ma) = 0.00 Kg/m²

Scale 1 : 3



Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Basement Floor
Description : Floor below ground level - solid floor construction
File reference : 1L177T3D49.FCF

Calculated 'U' value = 0.13W/m²K (Calculated in accordance with BS EN ISO 13370:2017)

Element Description	Element Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)	Mean T (K)	Delta T (K)
Inside surface	-	-	0.170	92.97	0.36
SAND CEMENT SCREED	75.0	1.400	0.054	92.73	0.11
POLYTHENE SEPARATION LAYER	0.5	-	0.001	92.67	0.00
KOOLTHERM K103	100.0	0.018	5.556	86.78	1.79
DAMP PROOF MEMBRANE	0.9	-	0.001	80.88	0.00
REINFORCED CONCRETE (2% STEEL)	100.0	2.500	0.040	80.84	0.08
Ground	-	-	0.040	80.75	0.08

Basement Details

Calculation method : BS EN ISO 13370: 2007
Perimeter : 31.00m
Area : 43.00m²
P/A : 0.721
Element : Basement floor
Average basement depth : 3.100m
Earth conductivity : 1.500
Soil type : Clay or Silt

Detailed U-value Calculation Results

Total resistance of basement floor
$R_T = (R_{upper} + R_{lower}) / 2 = (5.861 + 5.861) / 2 = 5.861$ m²K/W

(Correction for mechanical fasteners, Delta Uf = 0.0000W/m²K | Correction for air gaps, Delta Ug = 0.0000W/m²K)
(Alpha 0.0 m^{-1} | Fasteners per square metre 0.0000)
(Fasteners cross-sectional area 0.000 mm² | Thermal conductivity of fastener 0.00 W/mK)

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

For further information on the specified products, e.g. literature or specification clauses, please follows the links below:-

KOOLTHERM K103

Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Basement Floor
Description : Floor below ground level - solid floor construction
File reference : 1L177T3D49.FCF
Humidity Class: 3 - Dwellings with low occupancy
Location: 5a England SE & Central South

Condensation calculations performed in accordance with BS5250: 2011

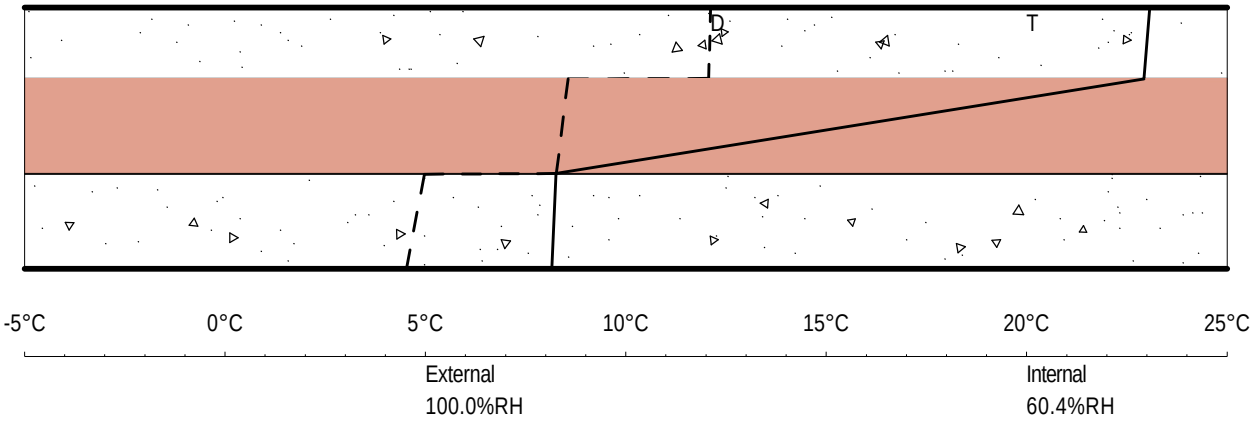
Condensation is occuring at the following layers interfaces:-
Interface 1 : DAMP PROOF MEMBRANE / KOOLTHERM K103

Month	Int (°C)	Int (%RH)	Ext/Grd (°C)	Ext/Grd (%RH)	Interface 1	
					Gc (Kg/m²)	Ma (Kg/m²)
Jan	20.0	61.5	1.5/5.0	90.0/100.0	0.00	0.00
Feb	20.0	60.4	1.8/4.5	86.5/100.0	0.00	0.00
Mar	20.0	59.7	3.7/4.7	84.0/100.0	0.00	0.00
Apr	20.0	59.1	6.0/5.6	81.0/100.0	0.00	0.00
May	20.0	61.0	9.3/6.8	81.0/100.0	0.00	0.00
Jun	20.0	63.8	12.4/8.4	80.0/100.0	0.00	0.00
Jul	20.0	67.3	14.5/10.0	80.5/100.0	0.00	0.00
Aug	20.0	68.0	14.1/11.0	82.5/100.0	0.00	0.00
Sep	20.0	66.2	11.8/10.8	85.5/100.0	0.00	0.00
Oct	20.0	63.9	8.7/9.7	88.0/100.0	0.00	0.00
Nov	20.0	61.8	4.4/8.1	89.5/100.0	0.00	0.00
Dec	20.0	61.7	2.5/6.0	90.5/100.0	0.00	0.00

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) = 0.00 Kg/m²
Annual moisture accumulation (Ma) = 0.00 Kg/m²
Peak moisture build-up month : January
Internal conditions : 20.0°C @ 60.4%RH
External conditions : 4.5°C @ 100.0%RH

Scale 1 : 8



Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Basement Floor
Description : Floor below ground level - solid floor construction
File reference : 1L177T42AF.FCF

Calculated 'U' value = 0.14W/m²K (Calculated in accordance with BS EN ISO 13370:2017)

Element Description	Element Thickness (mm)	Thermal Conductivity (W/mK)	Thermal Resistance (m²K/W)	Mean T (K)	Delta T (K)
Inside surface	-	-	0.170	92.97	0.36
SAND CEMENT SCREED	75.0	1.400	0.054	92.73	0.11
POLYTHENE SEPARATION LAYER	0.5	-	0.001	92.67	0.00
KOOLTHERM K103	100.0	0.018	5.556	86.78	1.79
DAMP PROOF MEMBRANE	0.9	-	0.001	80.88	0.00
REINFORCED CONCRETE (2% STEEL)	100.0	2.500	0.040	80.84	0.08
Ground	-	-	0.040	80.75	0.08

Basement Details

Calculation method : BS EN ISO 13370: 2007
Perimeter : 35.00m
Area : 43.00m²
P/A : 0.814
Element : Basement floor
Average basement depth : 0.800m
Earth conductivity : 1.500
Soil type : Clay or Silt

Detailed U-value Calculation Results

Total resistance of basement floor
$R_T = (R_{upper} + R_{lower}) / 2 = (5.861 + 5.861) / 2 = 5.861$ m²K/W

(Correction for mechanical fasteners, Delta Uf = 0.0000W/m²K | Correction for air gaps, Delta Ug = 0.0000W/m²K)
(Alpha 0.0 m^{-1} | Fasteners per square metre 0.0000)
(Fasteners cross-sectional area 0.000 mm² | Thermal conductivity of fastener 0.00 W/mK)

(Delta Uf + Delta Ug) is less than 3% of (1 / Rt) so U = (1 / Rt) = 0.14W/m²K

For further information on the specified products, e.g. literature or specification clauses, please follows the links below:-

KOOLTHERM K103

Project ID : 8 Pilgrim's Lane, London NW3 1SL
Structure element : Basement Floor
Description : Floor below ground level - solid floor construction
File reference : 1L177T42AF.FCF
Humidity Class: 3 - Dwellings with low occupancy
Location: 5a England SE & Central South

Condensation calculations performed in accordance with BS5250: 2011

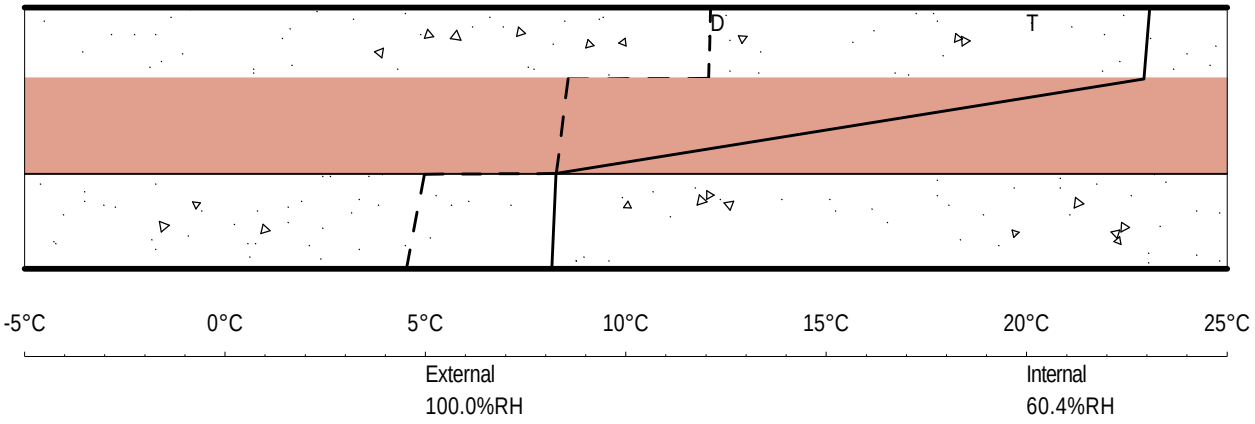
Condensation is occuring at the following layers interfaces:-
Interface 1 : DAMP PROOF MEMBRANE / KOOLTHERM K103

Month	Int (°C)	Int (%RH)	Ext/Grd (°C)	Ext/Grd (%RH)	Interface 1	
					Gc (Kg/m²)	Ma (Kg/m²)
Jan	20.0	61.5	1.5/5.0	90.0/100.0	0.00	0.00
Feb	20.0	60.4	1.8/4.5	86.5/100.0	0.00	0.00
Mar	20.0	59.7	3.7/4.7	84.0/100.0	0.00	0.00
Apr	20.0	59.1	6.0/5.6	81.0/100.0	0.00	0.00
May	20.0	61.0	9.3/6.8	81.0/100.0	0.00	0.00
Jun	20.0	63.8	12.4/8.4	80.0/100.0	0.00	0.00
Jul	20.0	67.3	14.5/10.0	80.5/100.0	0.00	0.00
Aug	20.0	68.0	14.1/11.0	82.5/100.0	0.00	0.00
Sep	20.0	66.2	11.8/10.8	85.5/100.0	0.00	0.00
Oct	20.0	63.9	8.7/9.7	88.0/100.0	0.00	0.00
Nov	20.0	61.8	4.4/8.1	89.5/100.0	0.00	0.00
Dec	20.0	61.7	2.5/6.0	90.5/100.0	0.00	0.00

Gc = Monthly moisture accumulation per area at an interface
Ma = Accumulated moisture content per area at an interface

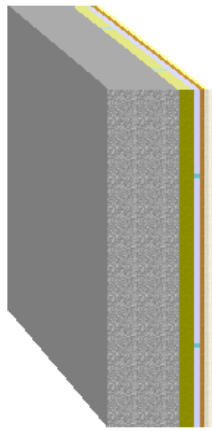
Peak accumulated moisture content per area at interface (Ma) = 0.00 Kg/m²
Annual moisture accumulation (Ma) = 0.00 Kg/m²
Peak moisture build-up month : January
Internal conditions : 20.0°C @ 60.4%RH
External conditions : 4.5°C @ 100.0%RH

Scale 1 : 8



Documentation of the component
Thermal transmittance (U-value)
Source: **own catalogue - External walls**
Component: **NCHE12048- 8 Pilgrims Lane, London, Basement Wall**

OUTSIDE INSIDE



This illustration of inhomogeneous layers is provided only to assist in visualising the arrangement.

On the basis of the given information about the inhomogeneous layers, it is not possible to estimate how and where bearing elements intersect each other. It was assumed that the layers intersect crosswise. The size of the areas was calculated corresponding to their percentage of the whole area.

Assignment: Basement wall

		Manufacturer	Name	Thickness [m], number	Lambda [W/(mK)]	Q	R [m²K/W]
		Rse					0.0000
☑	1	BS EN 12524	Concrete, Reinforced (with 1% of steel)	0.2500	2.300	D	0.1087
☑	2	BS EN 12524	Ethylene propylene diene monomer (EPDM)	0.0012	0.250	D	0.0048
☑	3	Light steel-frame	consisting of:	0.0500	ø 0.185		0.2704
	3a	ROCKWOOL	RWA45	99.70 %	0.035	E	-
	3b	BS EN 12524	Steel	00.30 %	50.000	D	-
☑	4	Inhomogeneous material layer	consisting of:	0.0200	ø 0.257		0.0777
	4a	BS EN ISO 6946	Unventilated airspace large: horizontal heat flow Airspace: mean temp.: 10°C / deltaT: <5 K / Epsilon1: 0.9 W/(m²K) / Epsilon2: 0.9 W/(m²K)	99.70 %	0.108	D	-
	4b	BS EN 12524	Steel	00.30 %	50.000	D	-
☑	5	BS EN 12524	Plywood [500 kg/m³]	0.0180	0.130	D	0.1385
☑	6	Own catalogue	Insulation 0.022Wm/K	0.0150	0.022	E	0.6818
☑	7	Generic Building Materials	Standard wallboard plasterboard	0.0125	0.210	D	0.0595
		Rsi					0.1300
				0.3667			

U = 0.26 W/(m²K)

Explanation see next page

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A .. A: Data is entered and validated by the manufacturer or supplier. Data is continuously tested by 3rd party.
B .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C .. C: Data is entered and validated by the manufacturer or supplier.
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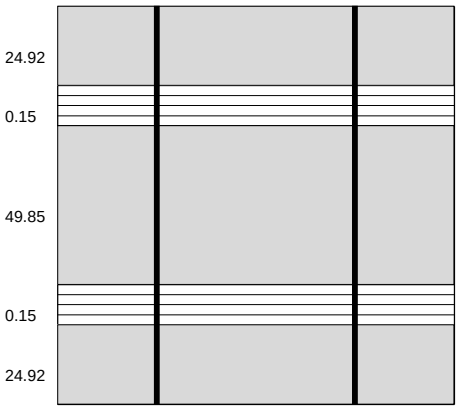
U_{max} = 0.35 W/(m²K) U = 0.26 W/(m²K) R_T = 2.14 m²K/W

Source of Umax value: England and Wales Approved Document L2A 2010 Tab 4 NonDwellings New

Source: **own catalogue - External walls**
Component: **NCHE12048- 8 Pilgrims Lane, London, Basement Wall**

Steel percentage: 0.30 %



Light steel-frame, inhomogeneous layer: sections

A	consisting of material layers: 1, 2, 3a, 4a, 5, 6, 7	= 99.40%
B	consisting of material layers: 1, 2, 3b, 4a, 5, 6, 7	= 0.30%
C	consisting of material layers: 1, 2, 3a, 4b, 5, 6, 7	= 0.30%
D	consisting of material layers: 1, 2, 3b, 4b, 5, 6, 7	= 0.00%

Upper limit of the thermal transfer resistance R

$$U_A\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,A}) + R_{si} + R_{se}} = \frac{1}{2.61 + 0.13 + 0} = 0.37$$

$$U_B\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,B}) + R_{si} + R_{se}} = \frac{1}{1.18 + 0.13 + 0} = 0.76$$

$$U_C\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,C}) + R_{si} + R_{se}} = \frac{1}{2.42 + 0.13 + 0} = 0.39$$

$$U_D\ [W/(m^2K)] = \frac{1}{(\Sigma R_{i,D}) + R_{si} + R_{se}} = \frac{1}{0.99 + 0.13 + 0} = 0.89$$

$$R_T' = \frac{1}{A * U_A + B * U_B + C * U_C + D * U_D} = 2.73\ m^2K/W$$

Lower limit of the thermal transfer resistance R

R_{se} [m²K/W]		= 0
R_1'' [m²K/W] = d_1/λ_1 =	0.2500 / 2.300	= 0.11
R_2'' [m²K/W] = d_2/λ_2 =	0.0012 / 0.250	= 0.00
R_3'' [m²K/W] = $d_3/(\lambda_{3a} * (A + C) + \lambda_{3b} * (B + D))$ =	0.0500 /(0.035 * 99.70% + 50.000 * 0.30%)	= 0.27
R_4'' [m²K/W] = $d_4/(\lambda_{4a} * (A + B) + \lambda_{4b} * (C + D))$ =	0.0200 /(0.108 * 99.70% + 50.000 * 0.30%)	= 0.08
R_5'' [m²K/W] = d_5/λ_5 =	0.0180 / 0.130	= 0.14
R_6'' [m²K/W] = d_6/λ_6 =	0.0150 / 0.022	= 0.68
R_7'' [m²K/W] = d_7/λ_7 =	0.0125 / 0.210	= 0.06
R_{si} [m²K/W]		= 0.13

$$R_T'' = \Sigma R_i'' + R_{si} + R_{se} = 1.47\ m^2K/W$$

Source: **own catalogue - External walls**
Component: **NCHE12048- 8 Pilgrims Lane, London, Basement Wall**

Kind of frame:	Hybrid frame
Flange width:	known not to exceed 50 mm
Stud spacing s [m]:	0.600
Stud depth d [m]:	0.050
Web thickness t [m]:	0.00180
Steel percentage [%]:	0.30

Weight factor p
Formula: $p = 0,8 * (R_T''/R_T') + 0,32 - 0,2 * (0,6/s) - 0,04 * (d/0,1) =$**0.532**

$$R_T = p*R_T' + (1-p)*R_T'' = 2.14\ m^2K/W$$

Wall of a heated basement according to BS EN ISO 13370

Input data:

λ	Thermal conductivity [W/(mK)]	1.50	(Thermal conductivity of the ground)
P	Exposed perimeter [m]	31.00	
R_w	Thermal resistance [m²K/W]	2.009	(see construction layer list)
w	Thickness of walls [m]	0.367	(see construction layer list)
R_f	Thermal resistance [m²K/W]	2.000	(thermal resistance of basement floor)
z	Basement of depth [m]	3.10	

Intermediate results:

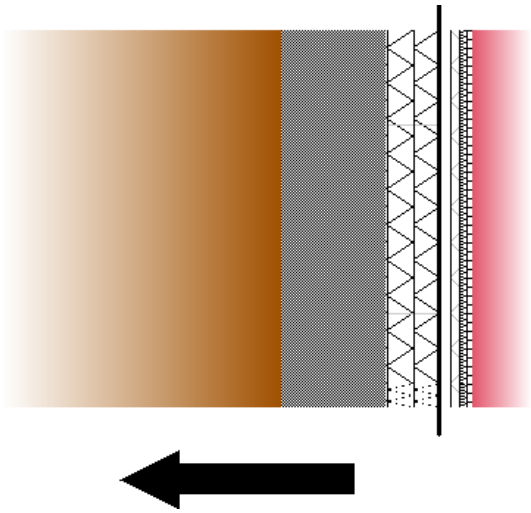
d_t	Equivalent thickness [m]	3.682
d_w	Equivalent thickness [m]	3.269
U_{bw}	Thermal transmittance [W/(m²K)]	0.258

$U = 0.26$ W/(m²K) **Thermal Transmittance**

$L_S = 24.8$ W/K **Steady-state thermal coupling coefficient**

Source: **own catalogue - External walls**
Component: **NCHE12048- 8 Pilgrims Lane, London, Basement Wall**

OUTSIDE INSIDE



The list of materials shown below may differ from those in the U-value calculation printout. Only material layers which are used in the heat capacity calculation are listed.

Single material layers shown in the U-value calculation printout may be separated to meet the exclusion criteria:

A .. The total thickness of the layers exceed 0.1 m.
B .. The mid point in the construction is reached.

For insulation layers the following criteria applies:

C .. An insulating layer is reached (defined as lambda <= 0.08 W/(mK)).

	Name	Thickness [m]	lambda [W/(mK)]	Q	Thermal capacity [kJ/(kgK)]	Q	Density [kg/m³]	Q	Thermal mass kJ/(m²K)	Criteria Exclusion
	End of calculation - Earth									
1	Concrete, Reinforced (with 1% of steel)	0.2500	2.300	D	1.00	D	2300.0	D	~~575.0~~	A, -, C
2	Ethylene propylene diene monomer (EPDM)	0.0012	0.250	D	1.00	D	1150.0	D	~~1.4~~	A, -, C
3	Light steel-frame consisting of:	0.0155							~~0.2~~	A, -, -
3a	RWA45	99.70%	0.035	E	1.03	E	45.0	E	~~0.7~~	A, -, C
3b	Steel	00.30%	50.000	D	0.45	D	7800.0	D	~~0.2~~	A, -, -
3	Light steel-frame consisting of:	0.0345							0.4	-, -, -
3a	RWA45	99.70%	0.035	E	1.03	E	45.0	E	~~1.6~~	-, -, C
3b	Steel	00.30%	50.000	D	0.45	D	7800.0	D	0.4	-, -, -
4	Inhomogeneous material layer consisting of:	0.0200							0.2	-, -, -
4a	Unventilated airspace large: horizontal heat flow	99.70%	0.108	D	1.01	D	1.2	D	~~0.0~~	-, -, C
4b	Steel	00.30%	50.000	D	0.45	D	7800.0	D	0.2	-, -, -
5	Plywood [500 kg/m³]	0.0180	0.130	D	1.60	D	500.0	D	~~14.4~~	-, -, C
6	Insulation 0.022Wm/K	0.0150	0.022	E	1.40	E	29.0	E	~~0.0~~	-, -, C
7	Standard wallboard plasterboard	0.0125	0.210	D	1.00	D	700.0	D	8.8	-, -, -
	Start of calculation - Warm									
		0.3667							**9.3**	

Heat capacity = 9.3 kJ/(m²K)

The following exclusion criteria apply:
A .. The total thickness of the layers exceed 0.1 m.
C .. An insulating layer is reached (defined as lambda <= 0.08 W/(mK)).

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
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