RIBA STAGE 3 PLUS–THERMAL REPORT

MHBC-008-SD-RP101_REV01

REVISION HISTORY

REV.	DATE	PREP.	CHECK	APPR.	DESCRIPTION
00	12/10/2022	SA	SZ	GG	First Release
01	28/10/2022	SA	SZ	GG	Second Release

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1. SCOPE OF WORK

Travelodge Euston is a mixed-use development. It incorporates the Travelodge Hotel, a retail unit, and residential units. The building is flanked on its northeaster face by Grafton Chambers.

As per report of the RIBA STAGE 1 the design involves only the following typologies:

1. Copper alloy standing seam panel EWS-1:
   - 001 – 50mm outer insulation wall
   - 002 – 100mm outer insulation wall
2. External wall insulation system EWS-2:
   - 001 – 50mm outer insulation wall
   - 002 – 25mm outer insulation wall
3. Spandrel panel EWS-3

During a building inspection, combustible material and missing or loose fire cavity barriers have been found in the external walls. Since the building is not compliant with the Fire Regulations, it must undergo remedial works to make it compliant with the current Fire Regulations. Approved document L (Conservation of fuel and power) sets the limit that a renovated thermal element must comply; the existing external wall thermal element that is being renovate should:

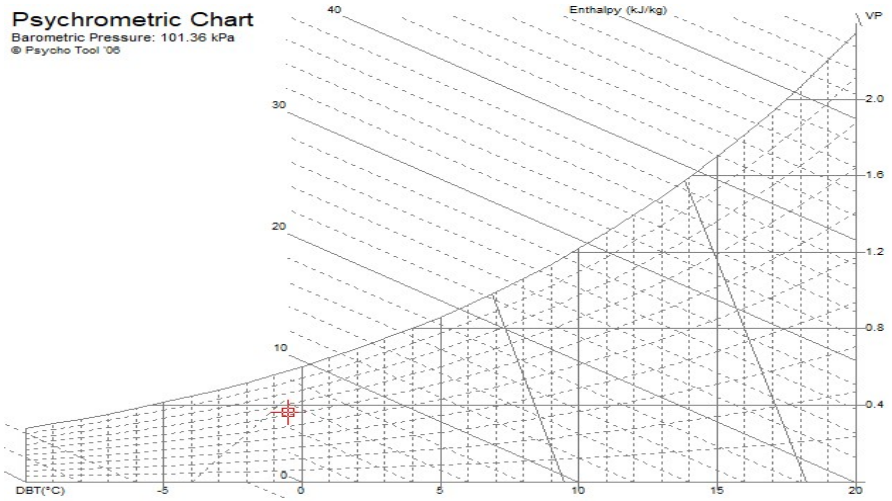
a) meet the limitation of 0,3 W/m²K

Scope of this document is to investigate the solution already provided in RIBA STAGE 3 report and check their feasibility in terms of thermal response.

2. DESIGN CRITERIA

2.1 Reference Documents

BS EN ISO 1035	Building materials. Thermal conductivities and vapour permeabilities.
BD EN ISO 13788	Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation.
BS EN ISO 6946	Building components and building elements — Thermal resistance and thermal transmittance.
BS EN ISO 12631	Thermal performance of curtain walling. Calculation of thermal transmittance.



2.2 Boundary Conditions

- T-indoor: 20 °C
- T-outdoor: -9°C
- RH-indoor: 50%
- RH-outdoor: 60%
- T-dew-point: 9.5 °C

LONDON WEA CENTER, UNITED KINGDOM (WMO: 037780)

Lat:**51.52N** Long:**0.12W** Elev:**23** StdP: **101.05** Time zone:**0.00** Period:**82-92**

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
	99.6%	99%	99.6%			99%			0.4%		1%			
			DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
2	-2.6	-1.0	-6.7	2.2	-0.5	-5.4	2.4	0.7	14.0	9.5	13.0	6.4	5.8	40

Extreme Annual Design Conditions

Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB							
				Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
11.7	10.3	9.4	24.4	-3.2	30.0	3.1	2.5	-5.5	31.9	-7.3	33.3	-9.0	34.8	-11.3	36.6

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3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

LOCALIZATION: WEST ELEVATION – EUSTON SQUARE

3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

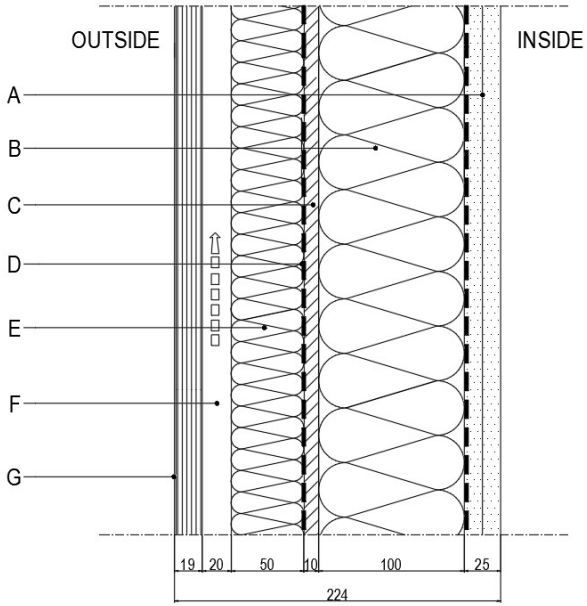
LOCALIZATION: SOUTH-EAST ELEVATION

3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

EWS-1_001: 50 mm OUTER INSULATION
CURRENT BUILT-UP SECTION

TRANSMITTANCE OF THE CENTER OF THE PANEL (FROM RIBA STAGE 3):

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board*	50	0,035	1,43
F	Cavity	20		0,18
G	Plywood	20	0,13	0,15
	External Heat Transfer Resistance	-	-	0,04
	U-value =		0,31 W/m²K	



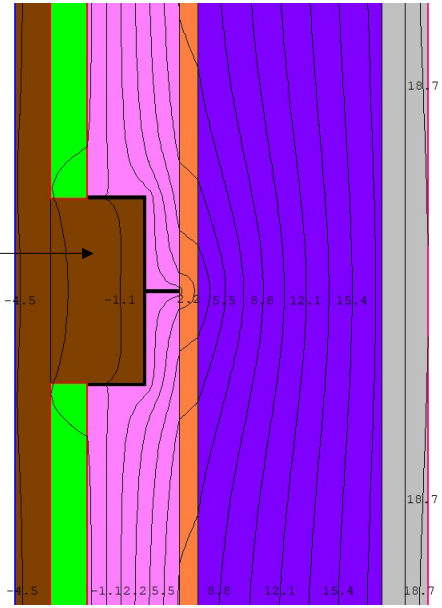
This calculation doesn't take into account the wooden battens and the steel brackets which would have a significant impact. That is why a thermal simulation has been made to asses the realistic performance of the panel.

CURRENT BUILD-UP PERFORMANCE INCLUDING BATTENS

Element	Description	U or Psi	S	A or L	UA
[-]	[-]	[W/mK]	[m]	[m²]	[W/K]
TJ + 50 mm	Wooden Button Impact+bracket	0,02	0,100	1,20	0,029
Panel	Center of panel	0,31	0,000	0,36	0,112
	U-value =		0,39 W/m²K		

- Wooden batten is considered through the horizontal sides of each module.
- The brackets are considered as one per each side of the panel, as the spacing of the SFS system. The equivalent conductivity is calculated to be inculded in the simulation.

The addition of the wooden batten and the bracket to the thermal analysis



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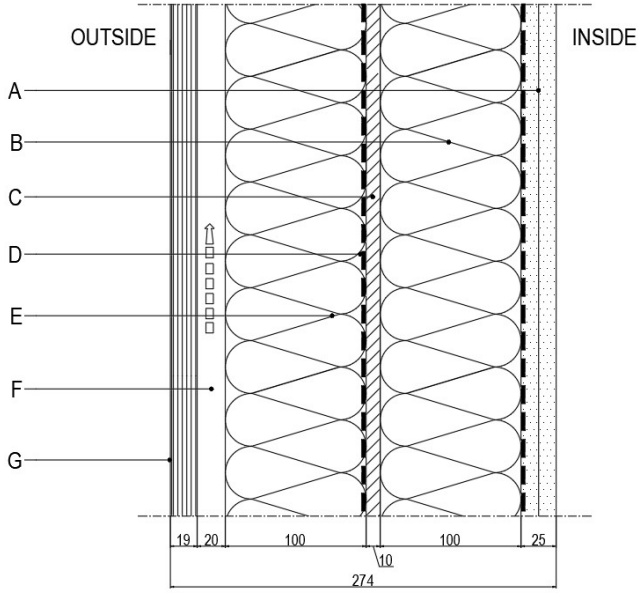
3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

EWS-1_001: 100 mm OUTER INSULATION
CURRENT BUILT-UP SECTION



TRANSMITTANCE OF THE CENTER OF THE PANEL (FROM RIBA STAGE 3):

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board*	100	0,035	2,86
F	Cavity	20		0,18
G	Plywood	20	0,13	0,15
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,21 W/m²K

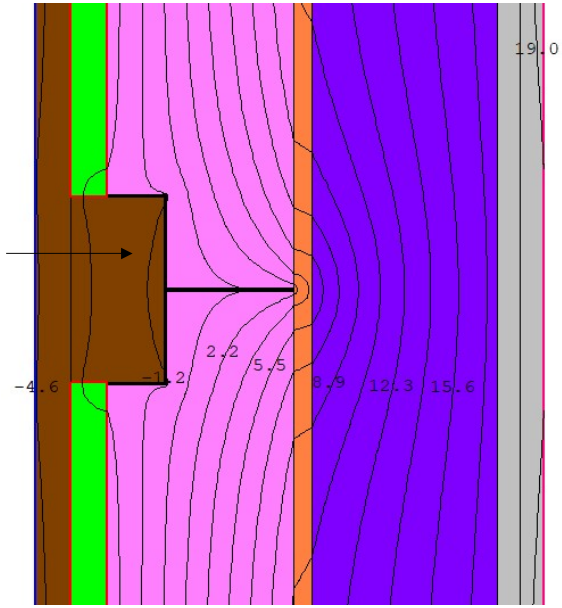
This calculation doesn't take into account the wooden battens and the steel brackets which would have a significant impact. That is why a thermal simulation has been made to asses the realistic performance of the panel.

CURRENT BUILD-UP PERFORMANCE INCLUDING BATTENS

Element	Description	U or Psi	S	A or L	UA
[-]	[-]	[W/mK]	[m]	[m²]	[W/K]
TJ + 100 mm	Wooden Button Impact+bracket	0,04	0,100	1,20	0,04
Panel	Center of panel	0,21	0,000	0,36	0,076
			U-value =		0,33 W/m²K

- Wooden batten is considered through the horizontal sides of each module.
- The brackets are considered as one per each side of the panel, as the spacing of the SFS system. The equivalent conductivity is calculated to be inculded in the simulation.

The addition of the wooden batten and the bracket to the thermal analysis



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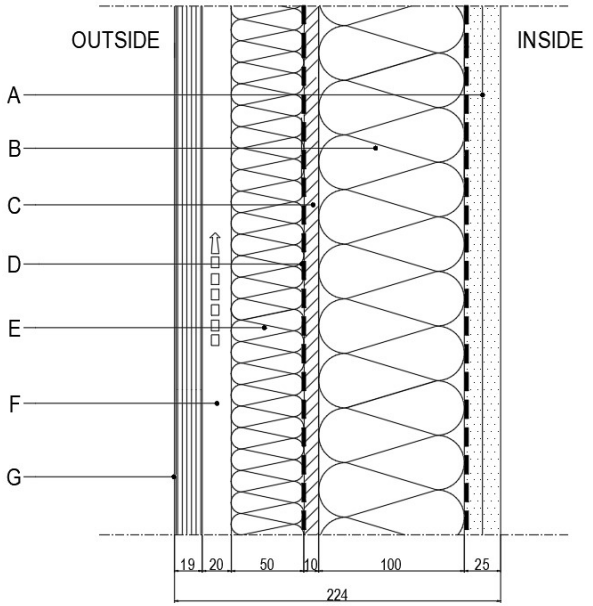
3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

EWS-1_001: 50 mm OUTER INSULATION

TRANSMITTANCE OF THE PANEL INCLUDING THE BATTENS

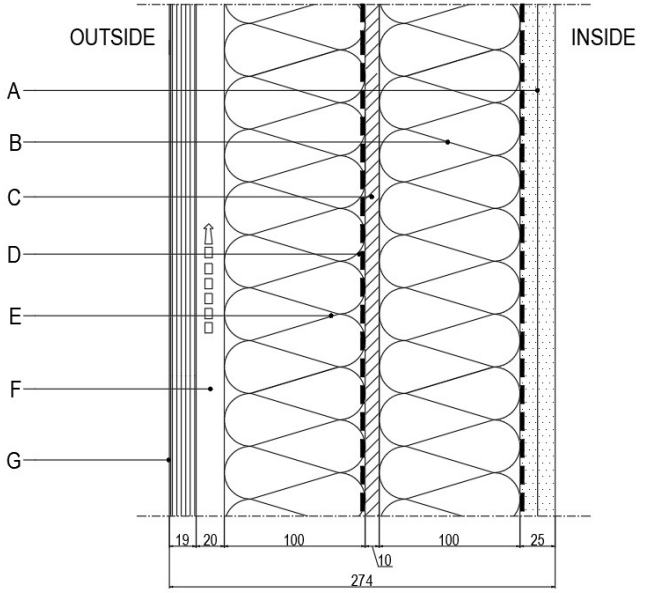
	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board*	50	0,035	1,43
F	Cavity	20		0,18
G	Plywood	20	0,13	0,15
	External Heat Transfer Resistance	-	-	0,04
			U-value =	0,31 W/m²K
			U-value + bracket	0,39 W/m²K



EWS-1_002: 100 mm OUTER INSULATION

TRANSMITTANCE OF THE PANEL INCLUDING THE BATTENS

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board*	100	0,035	2,86
F	Cavity	20		0,18
G	Plywood	20	0,13	0,15
	External Heat Transfer Resistance	-	-	0,04
			U-value =	0,21 W/m²K
			U-value + bracket	0,33 W/m²K



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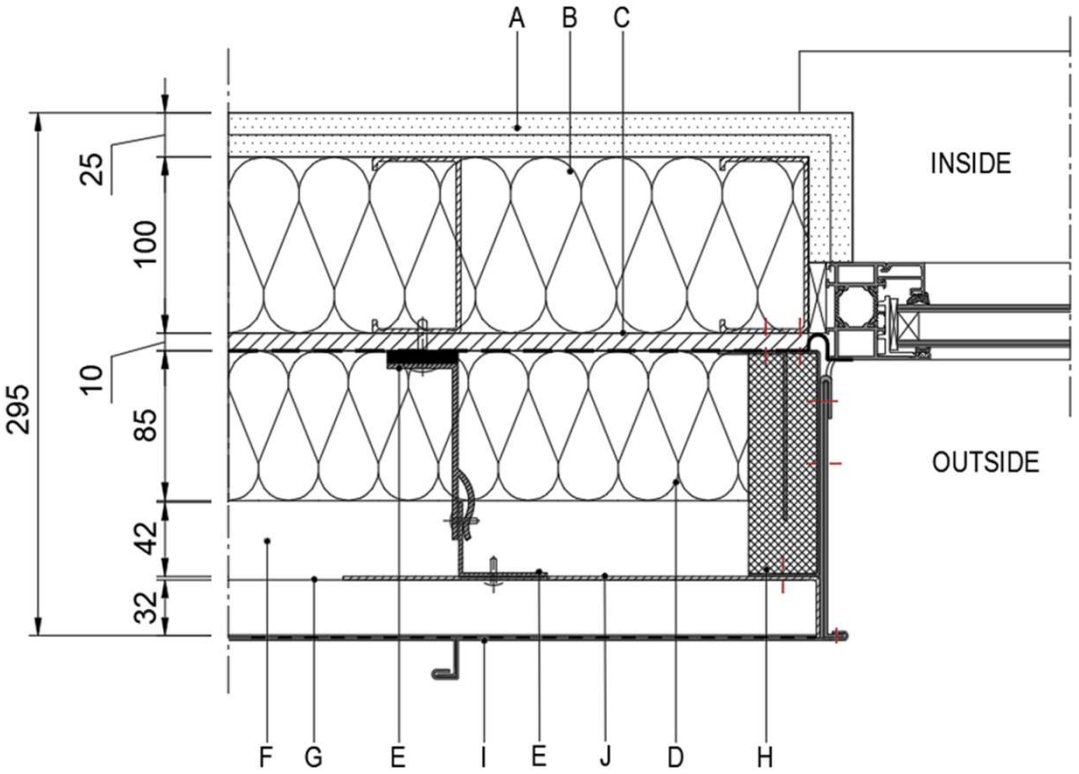
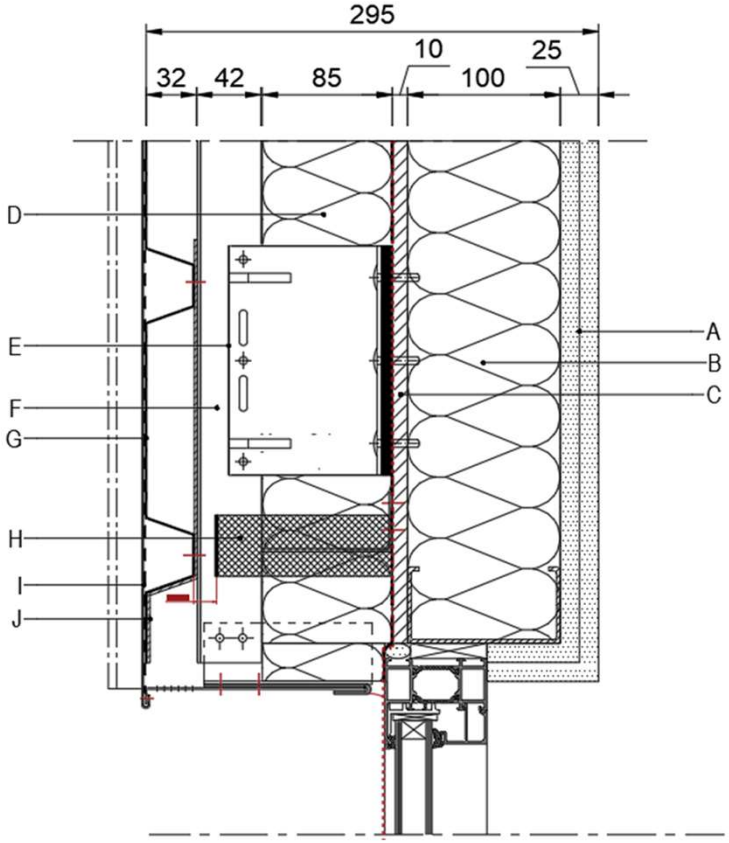
3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

EWS-1_001: 85 mm OUTER INSULATION

PROPOSAL 1 - STANDING SEAM AND CORRUGATED SHEET ON CONTINUOUS SUPPORT SYSTEM



HORIZONTAL SECTION



VERTICAL SECTION

STRATIGRAPHY

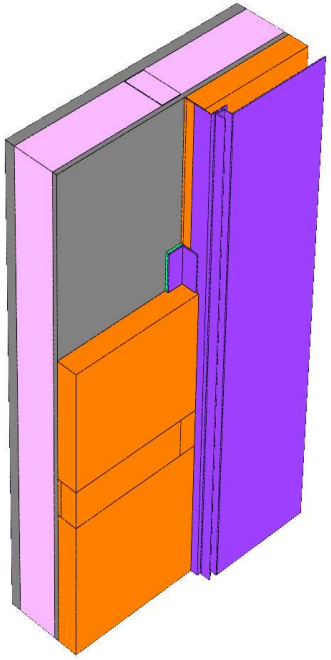
A - 2x12.5 PLASTERBOARD ON VAPOUR BARRIER
B - 100 MM METAL STUD WITH FULLFIL INSULATION + VAPOUR BARRIER
C - 10 MM PYROK BOARD + BREATHER MEMBRANE (CLASS A1)
D – MINERAL WOOL INSULATION (CLASS A1)
E – ALU BRACKET WITH CLIP + ALU L-PROFILE + CLASS A2 MEMBRANE (1 MM)
F – AIR CAVITY
G – STEEL DECK 0.7MM
H – FIRE CAVITY BARRIER WITH ALU BRACKETS
I- COPPER ALLOY STANDING SEAM
J- STEEL BENT PLATE

3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

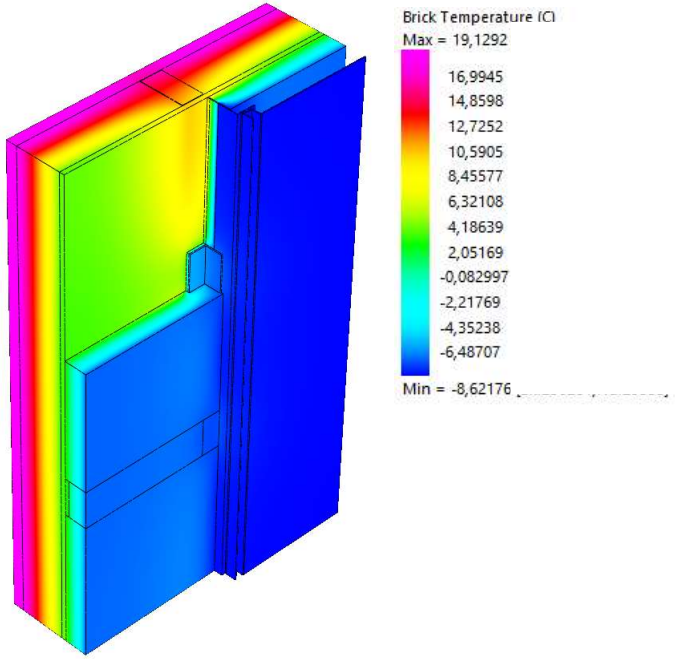
EWS-1_001: 85 mm OUTER INSULATION

PROPOSAL 1 - STANDING SEAM AND CORRUGATED SHEET ON CONTINUOUS SUPPORT SYSTEM

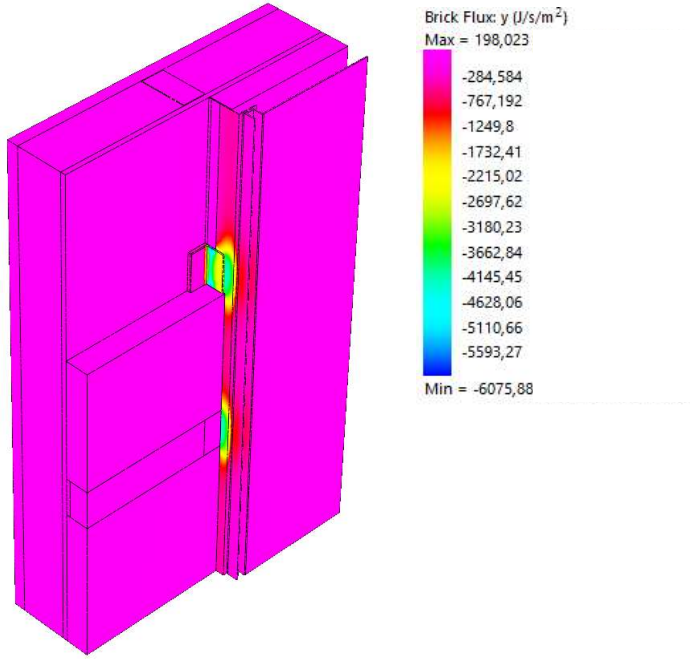
FINITE ELEMENT MODELLING AND RESULTS



ANALYTICAL MODEL



TEMPERATURE



HEAT TRANSFER

NOTE: Since only the external finish is varying between the proposal 1-2 and both are metallic, the same performance is expected for both solutions.

Color	Material	Conductivity [W/mK]
	Cavity	0,22
	Aluminum	160
	Mineral wool	0,035
	Glass wool	0,04
	Steel	50
	Spacer	0,2
	Boards	0,3

NO SURFACE CONDENSATION EXPECTED

phi	5.00	W
A	0,60	m2
phi/m2	8,33	W/m2
U	**0,29**	**W/m²K**

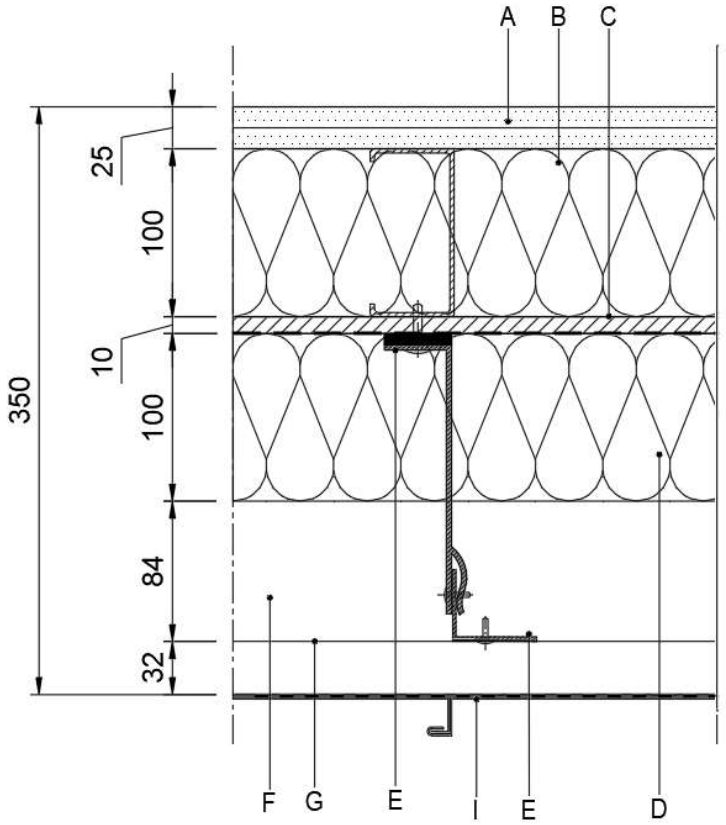
Approved document L criteria:	
a	OK

* Some elements have been hidden to show bracket location

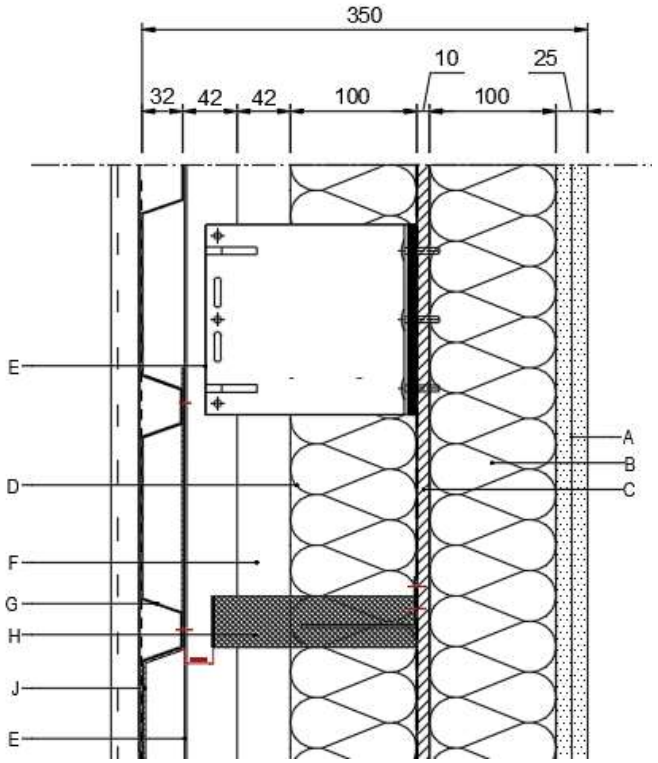
3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

EWS-1_002: 100 mm OUTER INSULATION

PROPOSAL 1 - STANDING SEAM AND CORRUGATED SHEET ON CONTINUOUS SUPPORT SYSTEM



HORIZONTAL SECTION



VERTICAL SECTION

STRATIGRAPHY

A - 2x12.5 PLASTERBOARD ON VAPOUR BARRIER

B - 100 MM METAL STUD WITH FULLFIL INSULATION + VAPOUR BARRIER

C - 10 MM PYROK BOARD + BREATHER MEMBRANE (CLASS A1)

D – MINERAL WOOL INSULATION (CLASS A1)

E – ALU BRACKET WITH CLIP + ALU L-PROFILE + CLASS A2 MEMBRANE (1 MM)

F – AIR CAVITY

G – STEEL DECK 0.7MM

H – FIRE CAVITY BARRIER WITH ALU BRACKETS

I- COPPER ALLOY STANDING SEAM

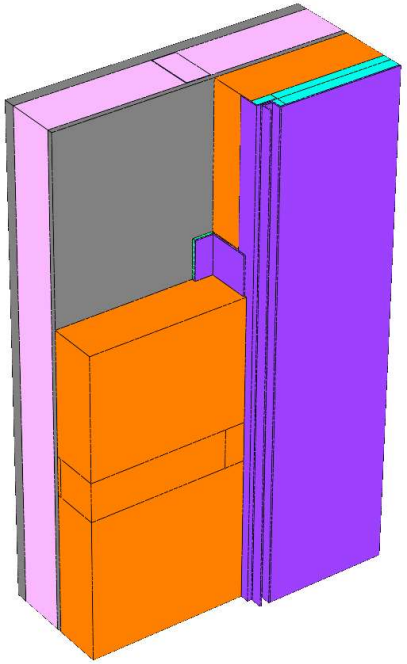
J- STEEL BENT PLATE

3. EWS-1: COPPER ALLOY STANDING SEAM PANEL

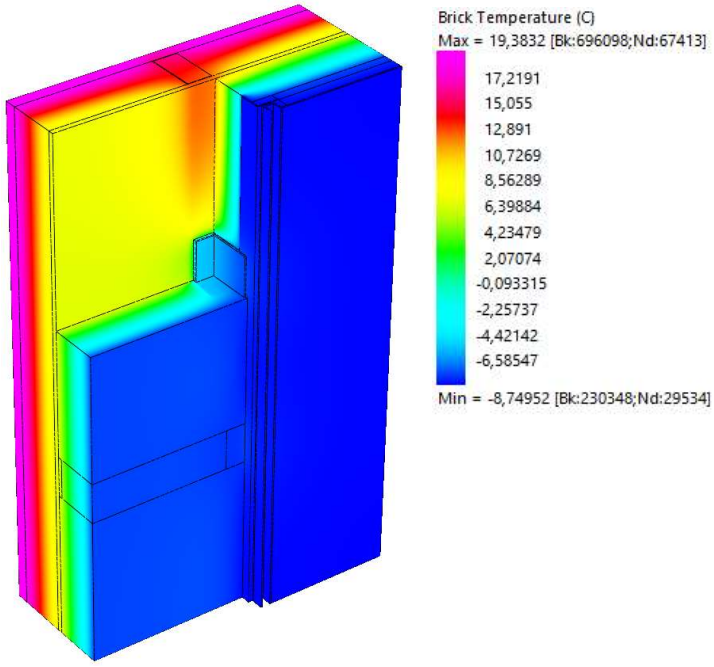
EWS-1_002: 100 mm OUTER INSULATION

PROPOSAL 1 - STANDING SEAM AND CORRUGATED SHEET ON CONTINUOUS SUPPORT SYSTEM

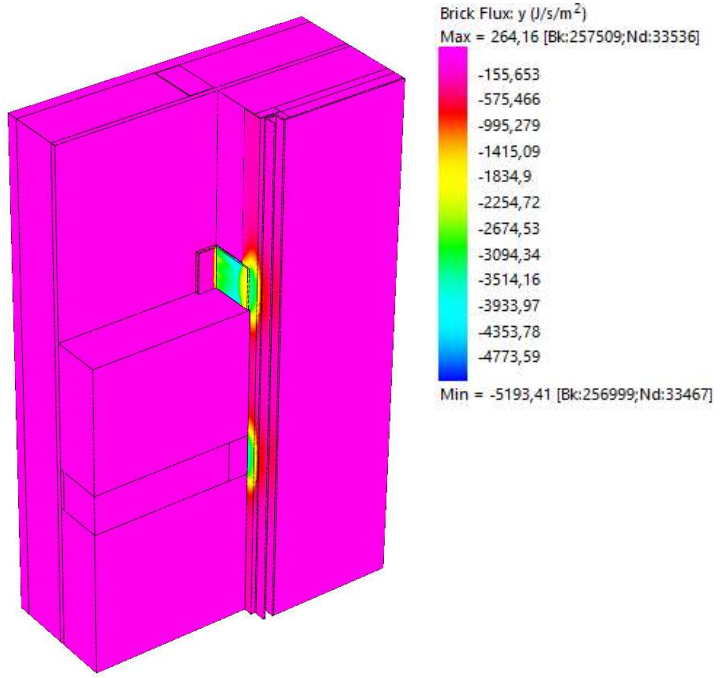
FINITE ELEMENT MODELLING AND RESULTS



ANALYTICAL MODEL



TEMPERATURE



HEAT TRANSFER

NOTE: Since only the external finish is varying between the proposal 1-2 and both are metallic, the same performance is expected for both solutions.

Color	Material	Conductivity [W/mK]
	Cavity	0,22
	Aluminum	160
	Mineral wool	0,035
	Glass wool	0,04
	Steel	50
	Spacer	0,2
	Boards	0,3

NO SURFACE CONDENSATION EXPECTED

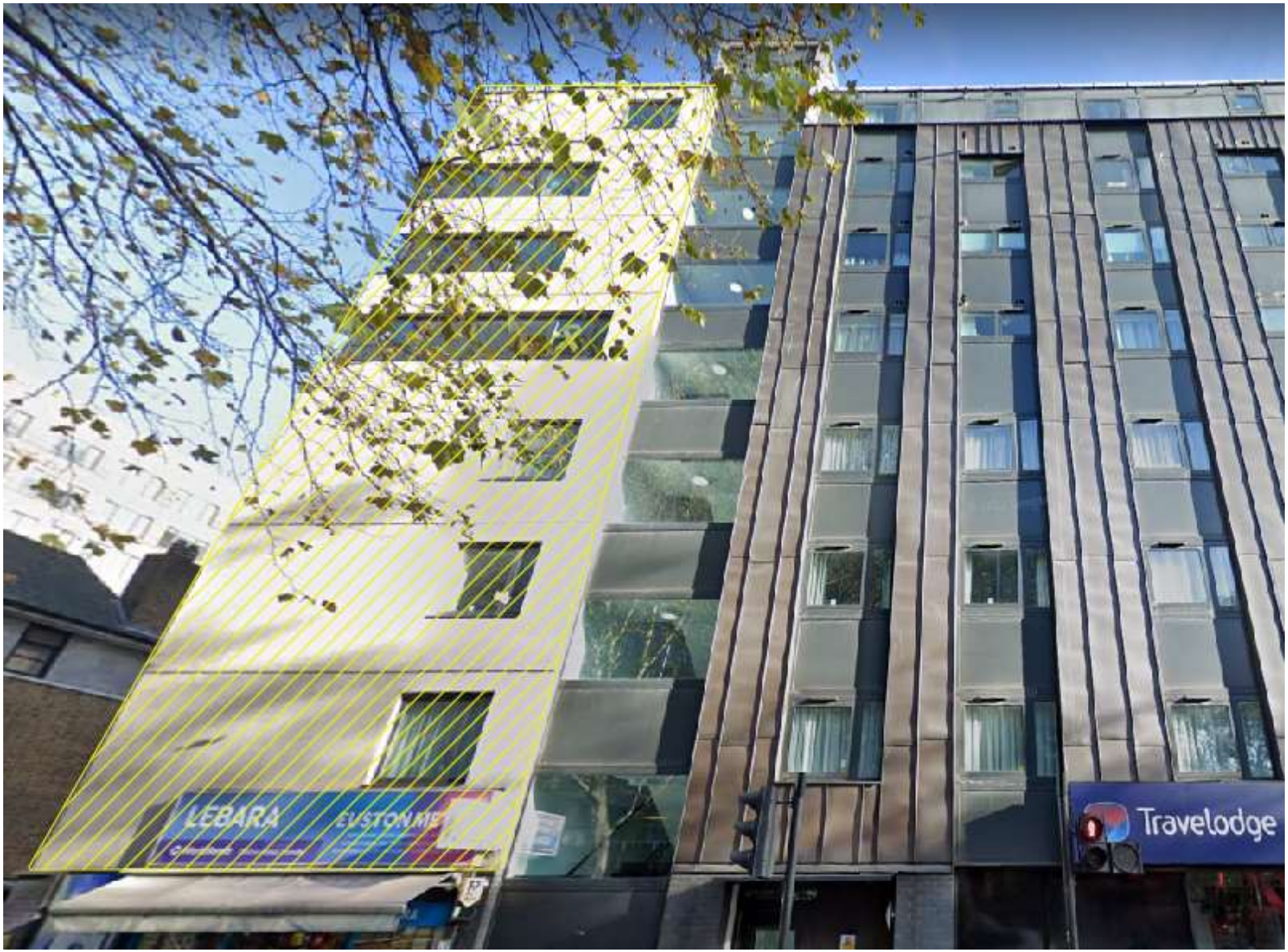
phi	4.79	W
A	0,60	m2
phi/m2	7.98	W/m2
U	**0,28**	**W/m²K**

Approved document L criteria:	
a	OK

* Some elements have been hidden to show bracket location

4. EWS-2: EXTERNAL WALL INSULATION SYSTEM

LOCALIZATION: WEST ELEVATION – EUSTON SQUARE

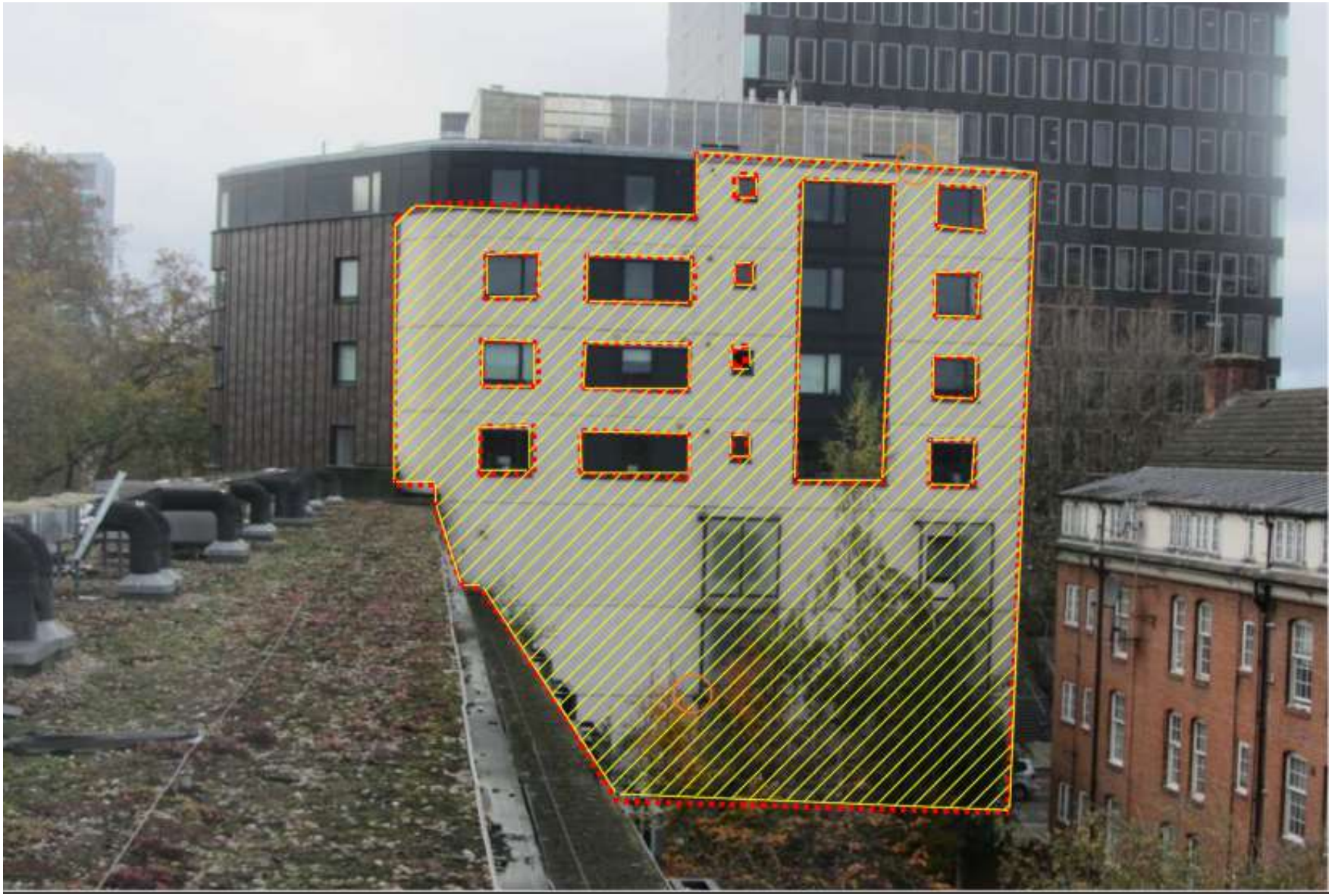


4. EWS-2: EXTERNAL WALL INSULATION SYSTEM

LOCALIZATION: NORTH-WEST ELEVATION

4. EWS-2: EXTERNAL WALL INSULATION SYSTEM

LOCALIZATION: EAST ELEVATION

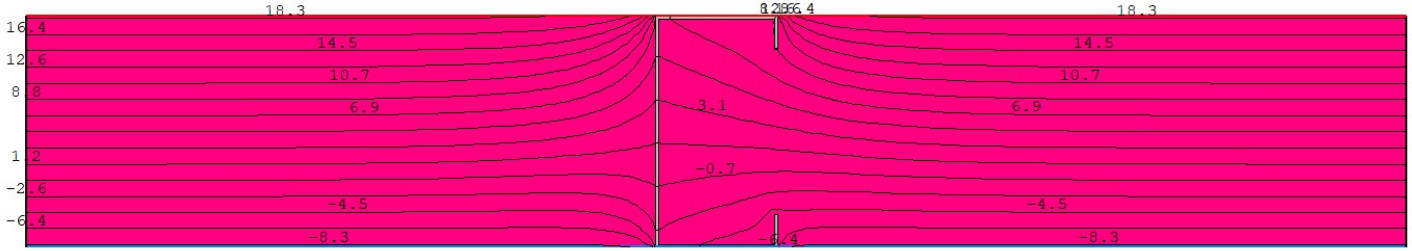


LOCALIZATION: NORTH-WEST ELEVATION – WELLESLEY PLACE

CALCULATION ON SFS EQUIVALENT CONDUCTIVITY

To evaluate the behaviour of the discontinuities within the layers, an equivalent thermal conductivity is determined, the spacing between battens is assumed as 600mm.

Battens: Steel λ = 50 W/mK
Insulation: Glass wool * λ = 0,04 W/mK



	U-factor W/m2-K	delta T C	Length mm	Rotation		Heat Flow W	Heat Flux W/m2
boundary1	0.6962	29.0	600	N/A	Projected X	12.1134	20.1890

$\lambda eq = s/R$

s = 0.1 m
R = 1/U – (1/he) – (1/hi) = 1.26 m²K/W

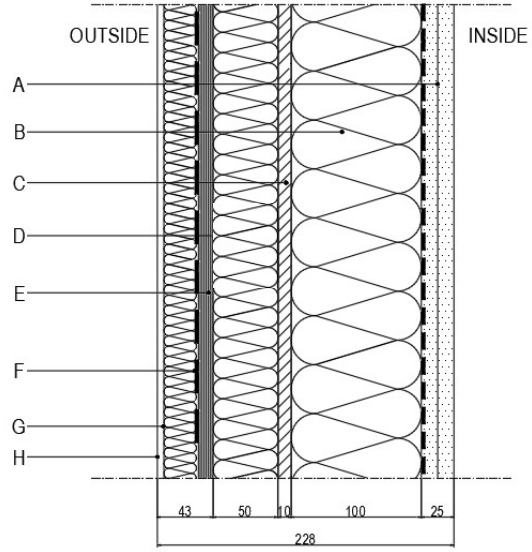
λ_{eq} = 0.079 W/mK

* According to “ARUP-AFE-278472-REP-001 DRAFT 31.03”.

4. EWS-2: EXTERNAL WALL INSULATION SYSTEM

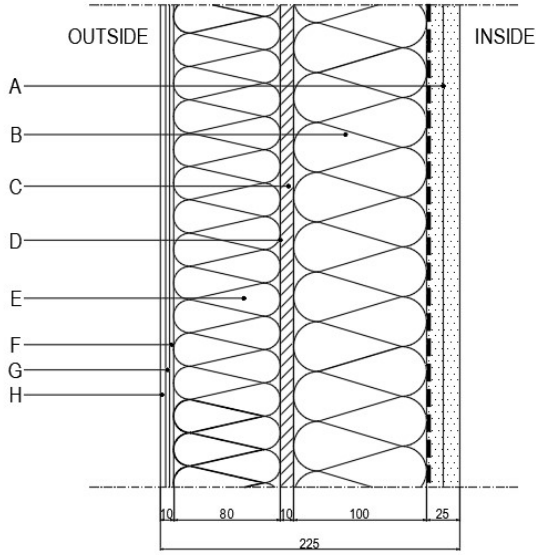
EWS-2_001: 50 mm OUTER INSULATION
CURRENT BUILT-UP

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral Wool Insulation *	50	0,035	1,43
F	Plywood sheating	10	0,13	0,08
G	Polystyrene Insulation *	25	0,035	0,71
H	Acrylic Render	5	0,2	0,03
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,27 W/m²K



EWS-2_001: 80 mm OUTER INSULATION
PROPOSED SOLUTION

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board	80	0,035	2,29
F-G-H	Mineralic reinforcing coat + glass fibre reinforcing mesh + primer and render finish	10	0,5	0,02
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,26 W/m²K



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a	OK

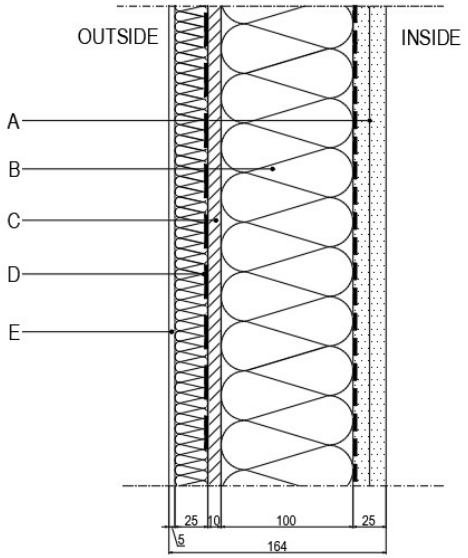
The solutions proposed does not affect negatively the facades thermal performances while maintaining the geometry of the current built-up sections.

* According to “ARUP-AFE-278472-REP-001 DRAFT 31.03”.

4. EWS-2: EXTERNAL WALL INSULATION SYSTEM

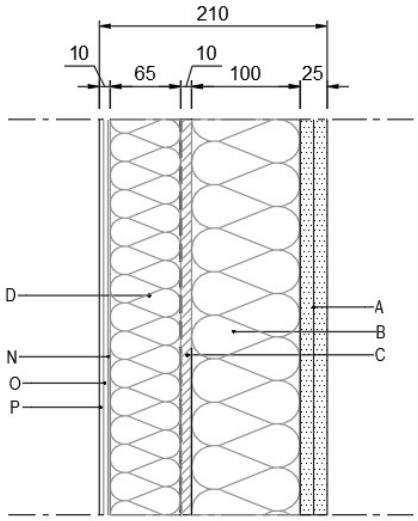
EWS-2_002: 25 mm OUTER INSULATION
CURRENT BUILT-UP

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation equivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Polystyrene Insulation *	25	0,035	0,71
F	Acrylic Render	5	0,2	0,03
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,45 W/m²K



EWS-2_002: 65 mm OUTER INSULATION
PROPOSED SOLUTION

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	100	0,079	1,27
C	Pyrok Board	10	0,23	0,04
D	Breather Membrane	1	0,2	0,01
E	Mineral fibre board	65	0,035	1.86
F-G-H	Mineralic reinforcing coat + glass fibre reinforcing mesh + primer and render finish	10	0,5	0,02
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,30W/m²K



Appoved document L citeria:	
a	OK

The solutions proposed does not affect negatively the facades thermal performances while maintaining the geometry of the current built-up sections.

* According to “ARUP-AFE-278472-REP-001 DRAFT 31.03”.

5. EWS-3: SPANDREL PANEL

LOCALIZATION: WEST ELEVATION – EUSTON SQUARE

5. EWS-3: SPANDREL PANEL

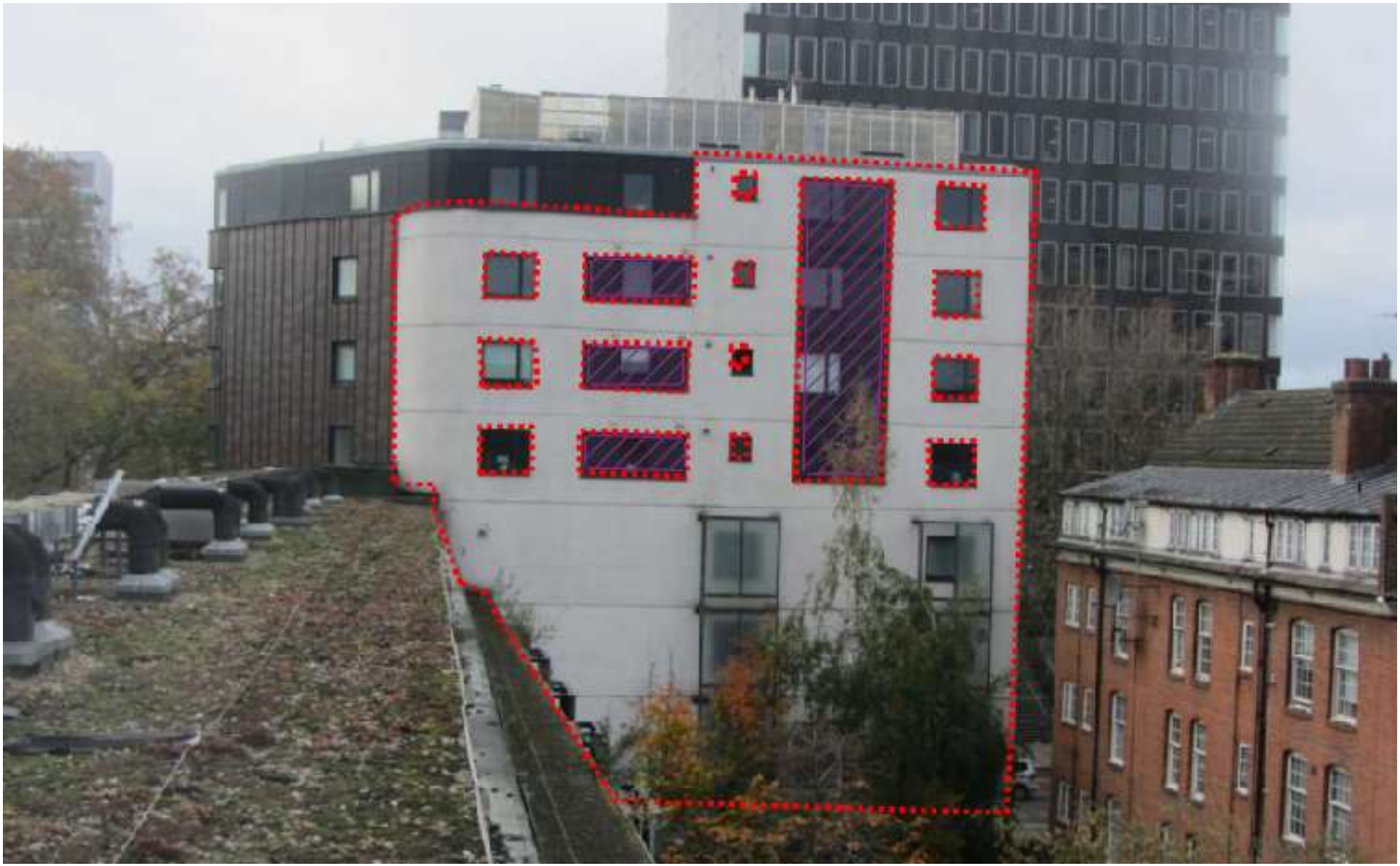
LOCALIZATION: SOUTH-EAST ELEVATION

5. EWS-3: SPANDREL PANEL

LOCALIZATION: NORTH-WEST ELEVATION

5. EWS-3: SPANDREL PANEL

LOCALIZATION: EAST ELEVATION



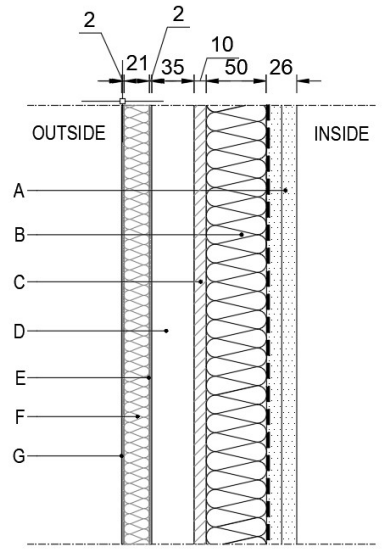
5. EWS-3: SPANDREL PANEL

LOCALIZATION: NORTH-WEST ELEVATION – WELLESLEY PLACE

5. EWS-3: SPANDREL PANEL

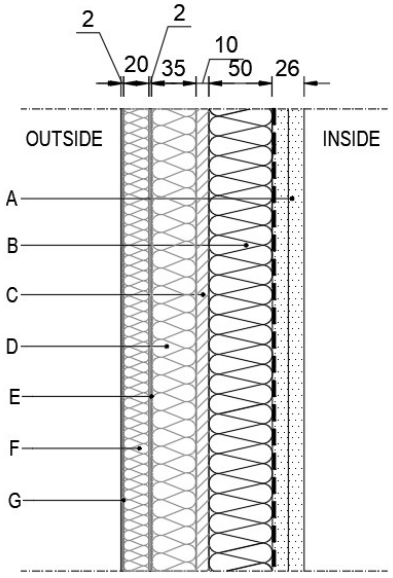
EWS-3
CURRENT BUILT-UP

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	50	0,079	0,63
C	Pyrok Board	10	0,23	0,04
D	Cavity	35	-	0,18
E	Aluminum sheet	2	160	0,00
F	Polystyrene Insulation **	20	0,035	0,57
G	Aluminium sheet	2	160	0,00
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,63 W/m²K



EWS-3
PROPOSED SOLUTION

	Material	Thickness [mm]	Thermal conductivity [W/mK]	Thermal resistance [m²K/W]
	Internal Heat Transfer Resistance	-	-	0.13
A	Plasterboard	25	0,21	0,12
B	Glass Wool Insulation eqivalent including SFS	50	0,079	0,63
C	Pyrok Board	10	0,23	0,04
D	Mineral Wool Insulation	35	0,035	0,86
E	Aluminum sheet	2	160	0,00
F	Mineral Wool Insulation	20	0,035	0,57
G	Aluminum sheet	2	160	0,00
	External Heat Transfer Resistance	-	-	0,04
	U-value =			0,44 W/m²K



Approved document L criteria:	
a	OK

The solutions proposed does not affect negatively the facades thermal performances while maintaining the geometry of the current built-up sections.

The above performance does not include losses due to the curtain wall aluminium framing.

** According to “Sandberg Report 67102c - Analysis of Insulation Samples - Travelodge Euston Central”.

6. CONCLUSIONS

Euston Travelodge External Wall Systems have been found to have combustible materials within the construction, therefore the Owner decided to replace any flammable material with a safer an more suitable material.

Thermal performance of proposed External Wall Systems for Euston Travelodge is determined through 3D and 1D thermal transmittance calculations.

Approved document L (Conservation of fuel and power) sets the limit that a renovated thermal element must comply. Some elements do not comply with limiting values, but the proposed solution are always at least as performing as the existing ones. In a later stage is must be confirmed that as part of this fire renovation the limiting values can be neglected.