Euston Travelodge
London

RIBA STAGE 3 PLUS – STRUCTURAL REPORT

MHBC-008-SD-RP102_REV01

REVISION HISTORY

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

INDEX OF CONTEXT

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

Scope of this document is to investigate the solution (Proposal 1) already provided in RIBA STAGE 3 report and check their feasibility in terms of loads involved and structural analysis.

Since the layers within the proposed solutions of EWS-2 and EWS-3 do not involve a relevant change in terms of weights to the SFS system, it was reported only the stability checks of the EWS-1.

2. DESIGN CRITERIA

2.1 REFERENCE DOCUMENTS

- BS EN 1990: Eurocode 0: Basis of structural design;
- BS-EN 1990: Eurocode 0: Basis of structural design – UK National Annex
- BS EN 1991-1-1: Eurocode 1: Actions on structures. General actions – Densities, self-weight, imposed loads for buildings;
- BS EN 1991-1-4: Eurocode 1: Actions on structures. General actions – Wind actions;
- BS EN 1991-1-4: Eurocode 1: Actions on structures. General actions – Wind actions – UK National Annex
- BS EN 1999-1-1: Eurocode 9: Design of Aluminium structures – General structures rules.
- BS EN 1993-1-8 : Eurocode 3: Design of joints

2.2 LOAD ANALYSIS

Dead Loads (DL)

Dead loads are considered in according to the table of BS EN 1991-1-1:

- Aluminium 27.0 kN/m^3
- Steel 78.5 kN/m^3
- Zinc 72 kN/m^3
- Copper 88 kN/m^3

Wind Load (WL)

Wind Load as per EN 1991-1-4:

Reference heigth:	$z = h =$	22.00	m
Terrain category:	IV		
Roughness length:	$z_0 =$	1.000	m
Minimum height:	$z_{min} =$	10	m
Maximum height:	$z_{max} =$	200	m
Fundamental value basic wind velocity:	$v_{b,0} =$	22.5	m/s
Directional factor:	$c_{dir} =$	1.00	
Season factor:	$c_{season} =$	1.00	
Basic wind velocity:	$v_b =$	22.5	m/s
Air density:	$\rho =$	1.23	kg/m^3
Turbulence factor:	$k_l =$	1.00	
Terrain factor:	$k_r =$	0.23	
Orography factor:	$c_o =$	1.00	
Turbulence intensity:	$I_v =$	0.32	
Roughness factor:	$c_r =$	0.72	
Mean wind velocity:	$v_m =$	16.3	m/s
Basic velcoity pressure:	$q_b =$	0.31	kPa
Exposure factor:	$c_e =$	1.71	
Effective load area:	$A_{eff} =$	5.00	m^2
Peak velocity pressure:	$q_p =$	**0.53**	**kPa**

Table 4.1 — Terrain categories and terrain parameters

Terrain category		z_0 m	z_{min} m
0	Sea or coastal area exposed to the open sea	0,003	1
I	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0,01	1
II	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0,05	2
III	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0,3	5
IV	Area in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m	1,0	10
NOTE: The terrain categories are illustrated in A.1.			

Pressure coefficients for interior and external wall

External pressure coefficients

Zone	A		B		C		D		E	
h/d	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$	$c_{pe,10}$	$c_{pe,1}$
5	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,7	
1	-1,2	-1,4	-0,8	-1,1	-0,5		+0,8	+1,0	-0,5	
≤ 0,25	-1,2	-1,4	-0,8	-1,1	-0,5		+0,7	+1,0	-0,3	

Interior pressure coefficients

Cpi = + 0.2

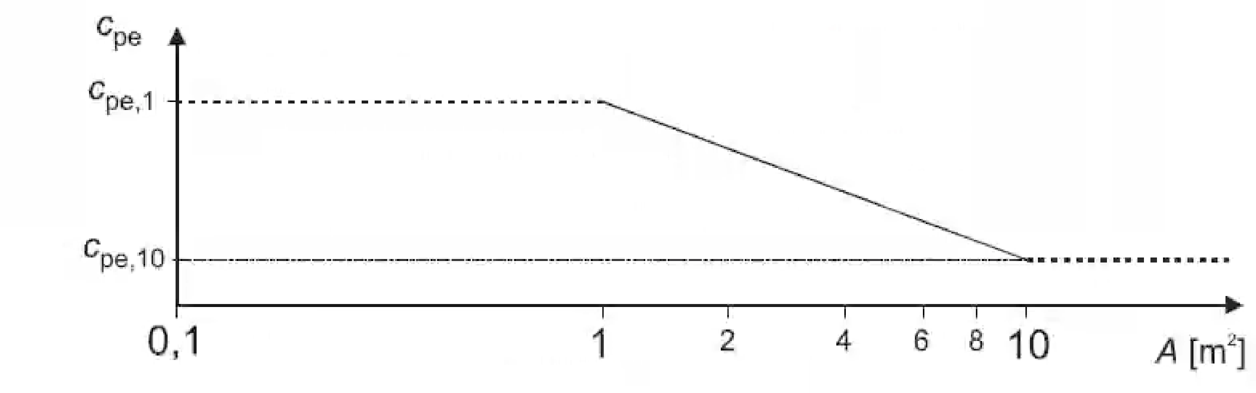
Cpe = - 0.3

Wsuc,cpe1 = 0.53 kN/m2 x (-1.4 - 0.2) = -0.85 kN/m2

Wpre,cpe1 = 0.53 kN/m2 x (1.0 + 0.3) = +0.70 kN/m2

Wsuc,cpe10 = 0.53 kN/m2 x (-1.2 - 0.2) = -0.74 kN/m2

Wpre,cpe10 = 0.53 kN/m2 x (0.7 + 0.3) = +0.53 kN/m2



The figure is based on the following:
for 1 m² < A < 10 m² $\qquad c_{pe} = c_{pe,1} - (c_{pe,1} - c_{pe,10}) \log_{10} A$

Figure 7.2 — Recommended procedure for determining the external pressure coefficient c_{pe} for buildings with a loaded area A between 1 m² and 10 m²

Verification Methodology

Aluminum members

For the verifications at Ultimate Limit State (ULS), the code BS EN 1990 §6.4.3.2 provides the combination of actions, as follow:

$$"\sum_{j\geq 1} \gamma_{G,j} G_{k,j}" + "\gamma_p P" + "\gamma_{Q,1} Q_{k,1}" + "\sum_{i>1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}"$$

The design of the structural members shall be verified with the partial factors actions - γ – from table A1.2(B).

Table A1.2(B) - Design values of actions (STR/GEO) (Set B)

Persistent and transient design situations	Permanent actions		Leading variable action	Accompanying variable actions (*)	
	Unfavourable	Favourable		Main (if any)	Others
(Eq. 6.10)	$\gamma_{Gj,sup}G_{kj,sup}$	$\gamma_{Gj,inf}G_{kj,inf}$	$\gamma_{Q,1}Q_{k,1}$		$\gamma_{Q,i}\psi_{0,i}Q_{k,i}$

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions (*)	
	Unfavourable	Favourable	Action	Main	Others
(Eq. 6.10a)	$\gamma_{Gj,sup}G_{kj,sup}$	$\gamma_{Gj,inf}G_{kj,inf}$		$\gamma_{Q,1}\psi_{0,1}Q_{k,1}$	$\gamma_{Q,i}\psi_{0,i}Q_{k,i}$
(Eq. 6.10b)	$\xi\gamma_{Gj,sup}G_{kj,sup}$	$\gamma_{Gj,inf}G_{kj,inf}$	$\gamma_{Q,1}Q_{k,1}$		$\gamma_{Q,i}\psi_{0,i}Q_{k,i}$

(*) Variable actions are those considered in Table A1.1

NOTE 1 The choice between 6.10, or 6.10a and 6.10b will be in the National annex. In case of 6.10a and 6.10b, the National annex may in addition modify 6.10a to include permanent actions only.

NOTE 2 The γ and ξ values may be set by the National annex. The following values for γ and ξ are recommended when using expressions 6.10, or 6.10a and 6.10b.
$\gamma_{Gj,sup} = 1,35$
$\gamma_{Gj,inf} = 1,00$
$\gamma_{Q,1} = 1,50$ where unfavourable (0 where favourable)
$\gamma_{Q,i} = 1,50$ where unfavourable (0 where favourable)
$\xi = 0,85$ (so that $\xi\gamma_{Gj,sup} = 0,85 \times 1,35 \cong 1,15$).
See also EN 1991 to EN 1999 for γ values to be used for imposed deformations.

NOTE 3 The characteristic values of all permanent actions from one source are multiplied by $\gamma_{G,sup}$ if the total resulting action effect is unfavourable and $\gamma_{G,inf}$ if the total resulting action effect is favourable. For example, all actions originating from the self weight of the structure may be considered as coming from one source ; this also applies if different materials are involved.

NOTE 4 For particular verifications, the values for γ_G and γ_Q may be subdivided into γ_g and γ_q and the model uncertainty factor γ_{Sd}. A value of γ_{Sd} in the range 1,05 to 1,15 can be used in most common cases and can be modified in the National annex.

The combination factors - Ψ - shall be obtained from Table NA.A1.1, BS EN 1990 - NA

Table NA.A1.1 — Values of Ψ factors for buildings

Action	Ψ_0	Ψ_1	Ψ_2
Imposed loads in buildings, category (see EN 1991-1.1)			
Category A: domestic, residential areas	0,7	0,5	0,3
Category B: office areas	0,7	0,5	0,3
Category C: congregation areas	0,7	0,7	0,6
Category D: shopping areas	0,7	0,7	0,6
Category E: storage areas	1,0	0,9	0,8
Category F: traffic area, vehicle weight ≤ 30 kN	0,7	0,7	0,6
Category G: traffic area, 30 kN < vehicle weight ≤ 160 kN	0,7	0,5	0,3
Category H: roofs[a]	0,7	0	0
Snow loads on buildings (see EN 1991-3)			
— for sites located at altitude H > 1 000 m a.s.l.	0,70	0,50	0,20
— for sites located at altitude H ≤ 1 000 m a.s.l.	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,5	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
[a] See also EN 1991-1-1: Clause 3.3.2 (1)			

For the verifications at Serviceability Limit State (SLS), the code BS EN 1990 6.5.3 provides the combination of actions, as follow:

$$"\sum_{j\geq 1} G_{k,j}" + "P" + "Q_{k,1}" + "\sum_{i>1} \psi_{0,i} Q_{k,i}"$$

The combination factors - Ψ - still refer to Table NA.A1.1, BS EN 1990 - NA.

Cladding Elements

For the analysis of the façade members, the following load combinations have been considered according to the standard BS EN 1990 Table NA.A1.1:

For the Ultimate Limit State (ULS):

$$"\sum_{j\geq 1} \gamma_{G,j} G_{k,j}" + "\gamma_P P" + "\gamma_{Q,1} Q_{k,1}" + "\sum_{i>1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}"$$

For the Serviceability Limit State (SLS).

$$"\sum_{j\geq 1} G_{k,j}" + "P" + \psi_1 "Q_{k,1}" + "\sum_{i>1} \psi_{2,i} Q_{k,i}"$$

or:

$$"\sum_{j\geq 1} G_{k,j}" + "P" + "Q_{k,1}" + "\sum_{i>1} \psi_{0,i} Q_{k,i}"$$

Structural Deflections

At both positive and negative applications of the peak test pressure, the maximum deflection shall not exceed:

- 1/90 of the span measured between the points of attachment of the panel.

Materials

The properties of extruded aluminium profiles are taken according to Table 3.2b of BS EN 1999-1-1:

Alloy EN-AW	Product form	Temper	Thickness t mm 1) 3)	f_o 1)	f_u 1)	A 5) 2)	$f_{o,haz}$ 4)	$f_{u,haz}$ 4)	HAZ-factor 4)		BC 6)	n_p 7)
				N/mm²		%	N/mm²		$\rho_{o,haz}$	$\rho_{u,haz}$		
5083	ET, EP,ER/B	O/ H111, F, H112	$t \leq 200$	**110**	**270**	12	110	270	1	1	B	5
	DT	H12/22/32	$t \leq 10$	200	280	6	135	270	0,68	0,96	B	14
		H14/24/34	$t \leq 5$	235	300	4			0,57	0,90	A	18
5454	ET, EP,ER/B	O/H111 F/H112	$t \leq$ **25**	85	200	16	85	200	1	1	B	5
5754	ET, EP,ER/B	O/H111 F/H112	$t \leq$ **25**	80	180	14	80	180	1	1	B	6
	DT	H14/ H24/H34	$t \leq 10$	180	240	4	100	180	0,56	0,75	B	16
6060	EP,ET,ER/B	T5	$t \leq$ **5**	120	160	8	50	80	0,42	0,50	B	17
	EP		$5 < t \leq 25$	100	140	8			0,50	0,57	B	14
	ET,EP,ER/B	T6	$t \leq$ **15**	**140**	**170**	8	60	100	0,43	0,59	A	24
	DT		$t \leq 20$	160	215	12			0,38	0,47	A	16
	EP,ET,ER/B	T64	$t \leq$ **15**	120	180	12	60	100	0,50	0,56	A	12
	EP,ET,ER/B	T66	$t \leq$ **3**	160	215	8	65	110	0,41	0,51	A	16
	EP		$3 < t \leq 25$	150	195	8			0,43	0,56	A	18
6061	EP,ET,ER/B	T4	t<**25**	110	**180**	15	95	150	0,86	0,83	B	8
	DT		$t \leq$ **20**	110	**205**	16				0,73	B	8
	EP,ET,ER/B	T6	t<**25**	240	**260**	**8**	115	175	0,48	0,67	A	55
	DT		$t \leq$ **20**	240	**290**	10				0,60	A	23
6063	EP,ET,ER/B	T5	$t \leq$ **3**	130	175	8	60	100	0,46	0,57	B	16
	EP		$3 < t \leq 25$	110	160	**7**			0,55	0,63	B	13
	EP,ET,ER/B	T6	$t \leq$ **25**	**160**	**195**	**8**	65	110	0,41	0,56	A	24
	DT		$t \leq 20$	190	220	10			0,34	0,50	A	31
	EP,ET,ER/B	T66	$t \leq$ **10**	200	245	**8**	75	130	0,38	0,53	A	22
	EP		$10 < t \leq 25$	180	225	8			0,42	0,58	A	21
	DT		$t \leq 20$	195	230	10			0,38	0,57	A	28
6005A	EP/O, ER/B	T6	$t \leq$ **5**	225	270	8	115	165	0,51	0,61	A	25
			$5 < t \leq 10$	215	260	8			0,53	0,63	A	24
			$10 < t \leq 25$	200	250	8			0,58	0,66	A	20
	EP/H, ET	T6	$t \leq 5$	**215**	**255**	8			0,53	0,65	A	26
			$5 < t \leq$ **10**	**200**	**250**	8			0,58	0,66	A	20
6106	EP	T6	$t \leq 10$	200	250	8	95	160	0,48	0,64	A	20

Standard BS EN 1999-1-1 defines the mechanical properties of aluminum:

Density γ = 2700 kg/m3
Elastic modulus E = 70 000 MPa
Shear modulus G = 21 000 MPa
Coefficient of linear thermal expansion αT = 23 x 10-6 1/°C

The partial factors γ_M should be applied to the various characteristic value of the resistance as follows according to BS EN 1999-1-1:

- resistance of cross-sections whatever the class is γ_{M1}
- resistance of member to instability assessed by member checks is γ_{M1}
- resistance of cross-sections in tension to fracture is γ_{M2}

The following value should be used:

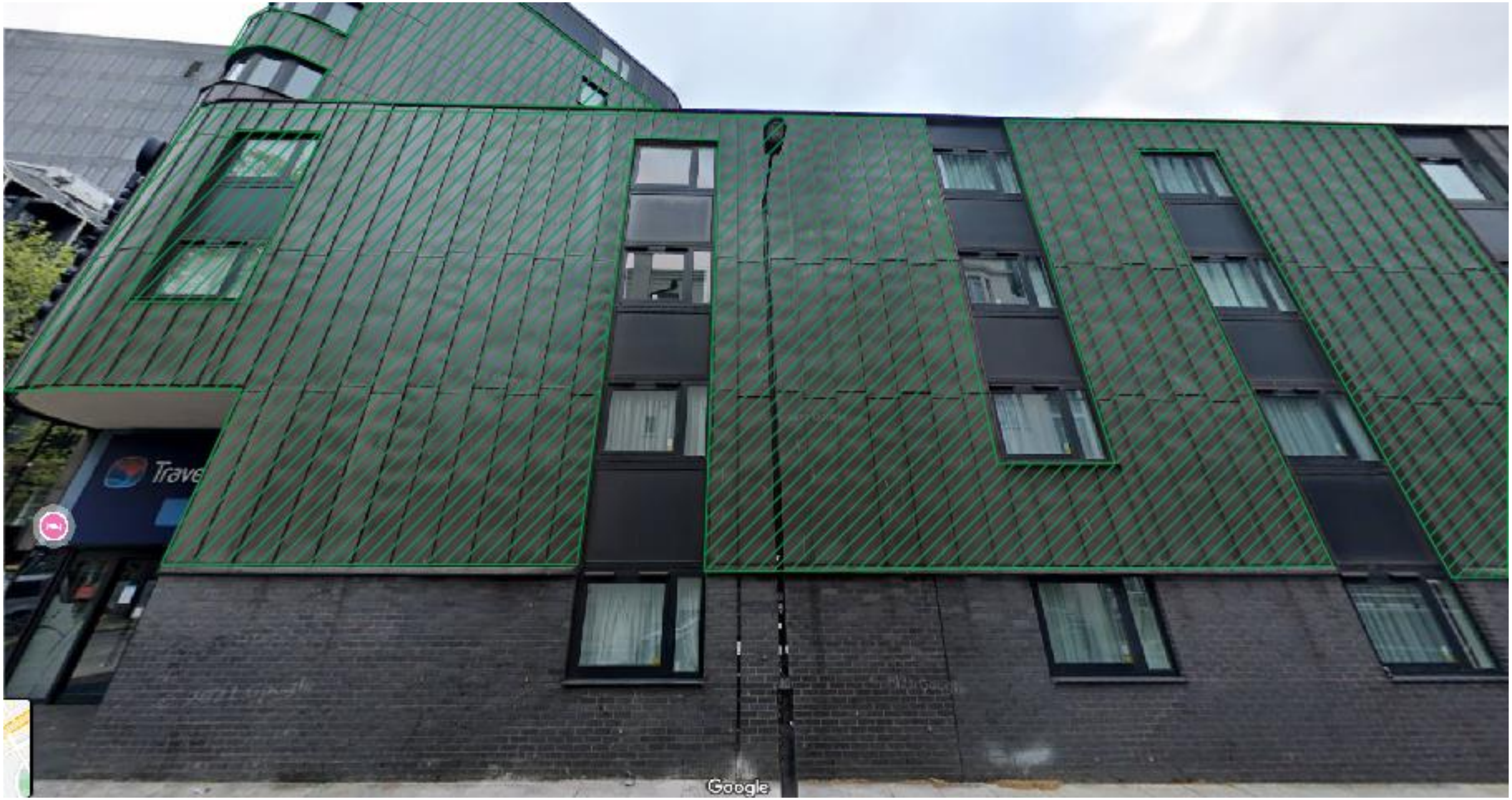
- γ_{M1} =1,10
- γ_{M2} =1,25

3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

LOCALIZATION: WEST ELEVATION – EUSTON SQUARE

3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

LOCALIZATION: SOUTH-EAST ELEVATION

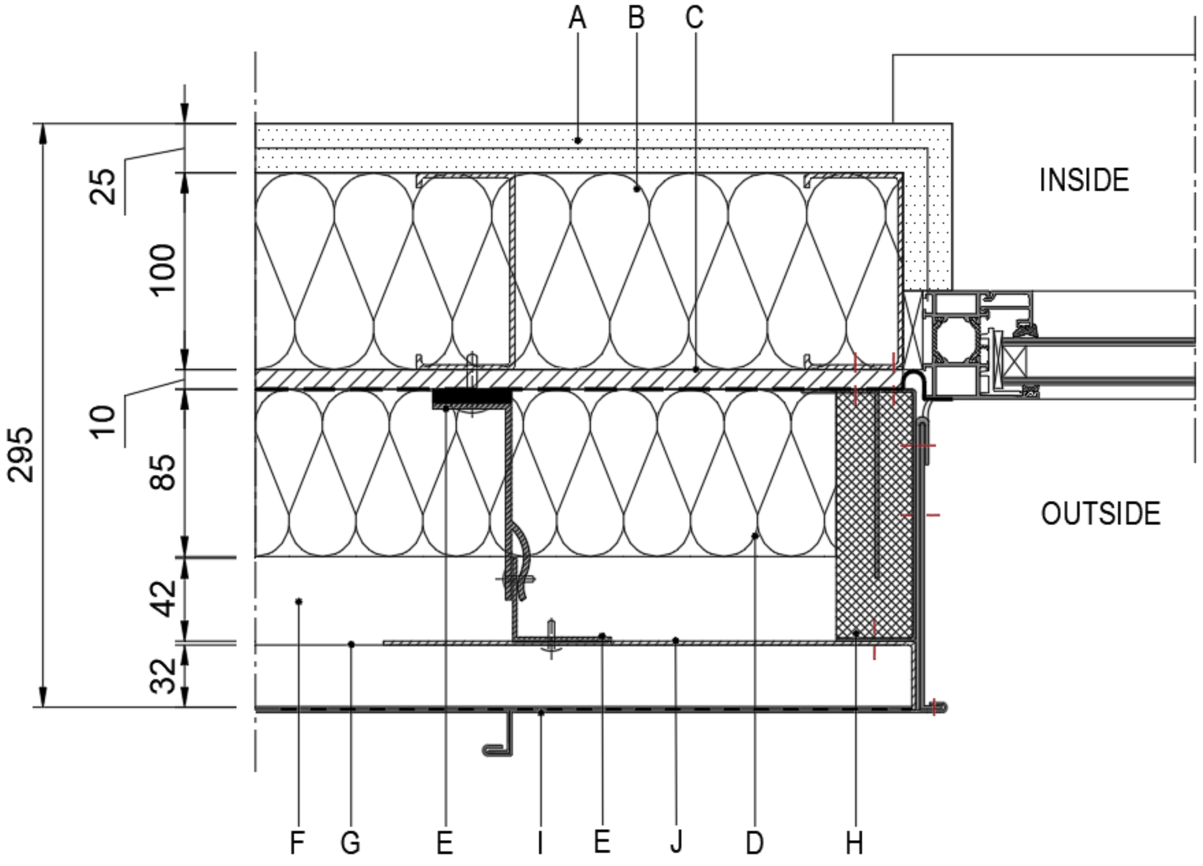


3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

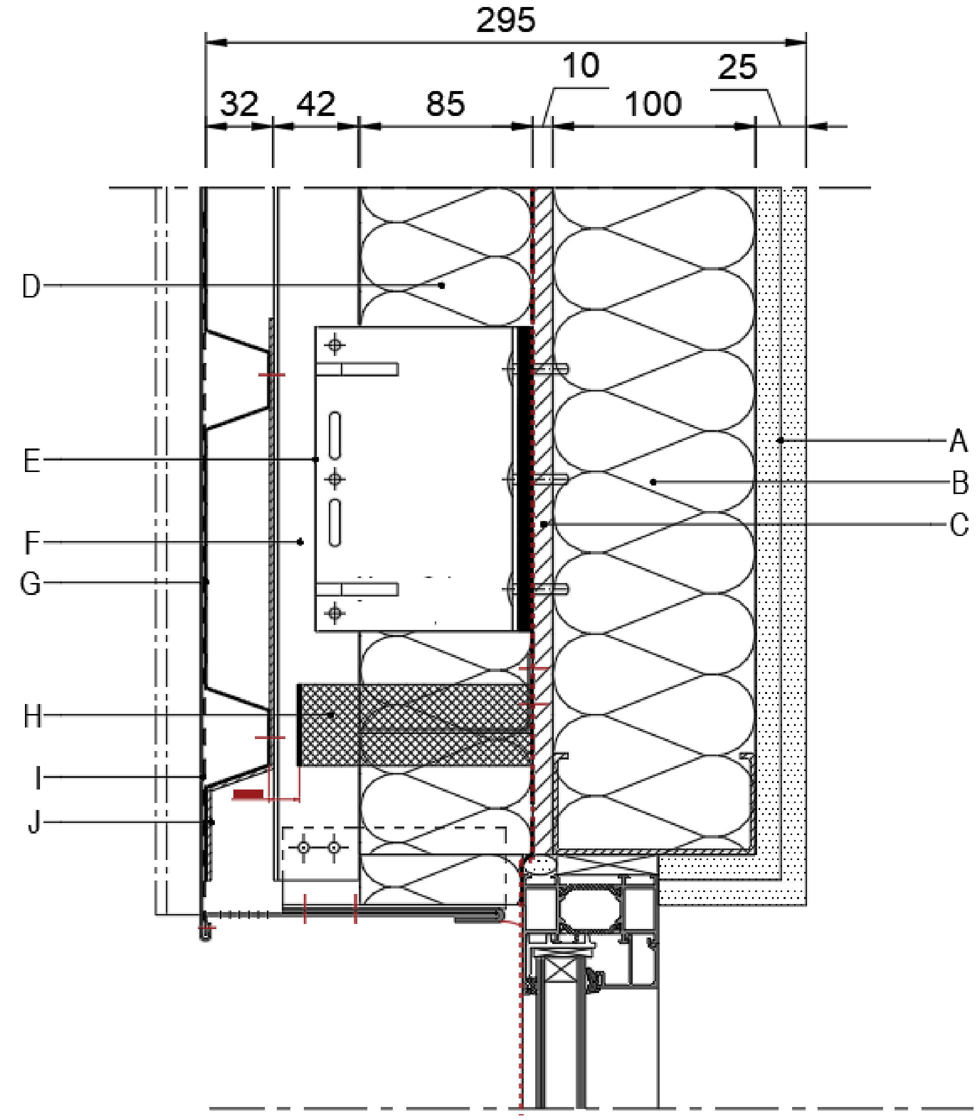
EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

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

In the images below are shown, as an example, the horizonal and vertical sections of EWS-1_001 (85 mm outer insulation)



HORIZONTAL SECTION



VERTICAL SECTION

MATERIAL LIST

*A. 2x12.5 Plasterboard on vapour barrier + 5 mm finiture

*B. 100 mm Metal stud with fullfil insulation + Vapour barrier

C. 10 mm Pyrok board* + Breather membrane [A2-S1, d0, or better]

D. Mineral wool insulation [Class A1]

E. Alu bracket with clip + Alu L-Profile + Class A2 Membrane Layer (1 mm) [A2-S1, d0, or better]

F. Air cavity

G. Steel deck 0.7 mm [A2-S1, d0, or better]

H. Fire cavity barrier with alu brackets as supporting system [A2-S1, d0, or better]

I. Copper Alloy Standing Seam [A2-S1, d0, or better] + Class A2 Membrane Layer with Metal Deck (1mm)

J. Steel Bent Plate

K. Aluminum Sandwich Panel with Mineral Wool

L. Fire cavity barrier with alu brackets at the Slab Edge [A2-S1, d0, or better]

M. Brickwork F^{10}_{110}

N. Mineral Reinforcing Coat

O. Glass Fiber Reinforcing Mesh

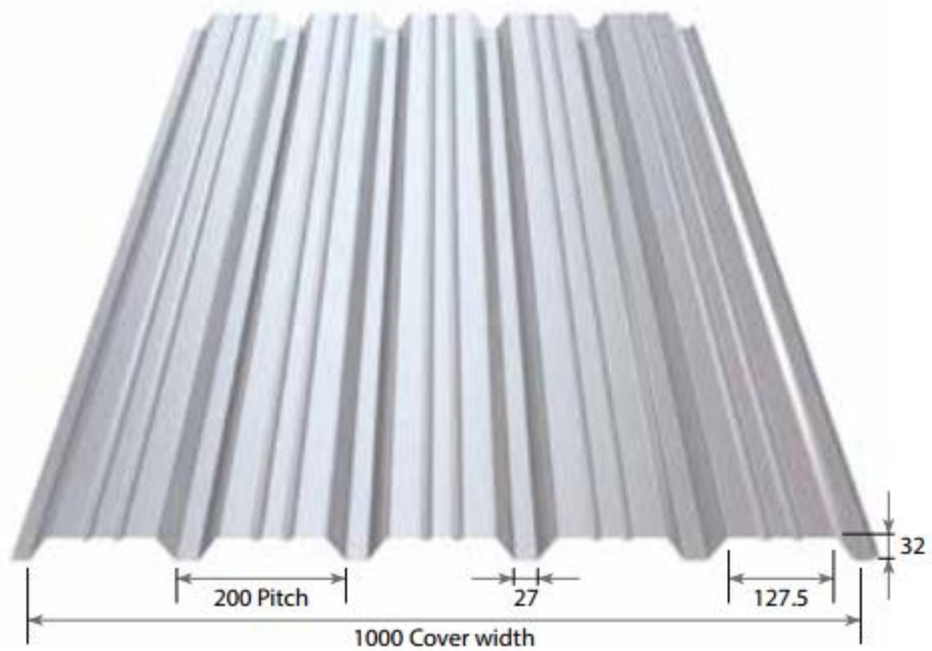
P. Primer and Render Finish

3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

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

THE STEEL DECH SHALL HAVE THE FOLLOWING CHARACTERISTICS:



Ultimate section properties to Eurocode

Material specification	Design thickness	Weight	Broad flange in compression: Moment capacity	Broad flange in compression: Moment of inertia	Narrow flange in compression: Moment capacity	Narrow flange in compression: Moment of inertia	65mm bearing on purlin: Transverse resistance: Internal Rw	65mm bearing on purlin: Transverse resistance: End Rw	65mm bearing on purlin: Shear capacity
	mm	kg/m²	kNm/m	cm⁴/m	kNm/m	cm⁴/m	kN/m	kN/m	kN/m
0.70mm Steel S280	0.66	6.82	1.59	11.12	1.24	10.08	10.98	5.49	42.08

	Span condition	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20	2.30	2.40
0.70mm Steel S280 Imposed	Single	8.09	7.28	6.61	5.12	4.01	3.20	2.59	2.12	1.76	1.47	1.24	–	–	–	–	–
0.70mm Steel S280 Imposed	Double	5.17	4.47	3.91	3.45	3.07	2.75	2.48	2.25	2.05	1.87	1.72	1.59	1.47	1.36	1.26	1.18
0.70mm Steel S280 Imposed	Multi	6.08	5.27	4.62	4.08	3.64	3.27	2.96	2.68	2.45	2.25	2.07	1.91	1.76	1.52	1.32	1.16
0.70mm Steel S280 Suction	Single	8.18	6.63	5.49	4.62	3.94	3.41	2.97	2.62	2.27	1.93	1.65	–	–	–	–	–
0.70mm Steel S280 Suction	Double	10.51	8.52	7.05	5.93	5.06	4.37	3.81	3.35	2.98	2.66	2.39	2.16	1.97	1.80	1.65	1.52
0.70mm Steel S280 Suction	Multi	12.75	10.34	8.55	7.19	6.13	5.30	4.62	4.06	3.61	3.22	2.90	2.62	2.28	1.99	1.75	1.55

Span (metres)

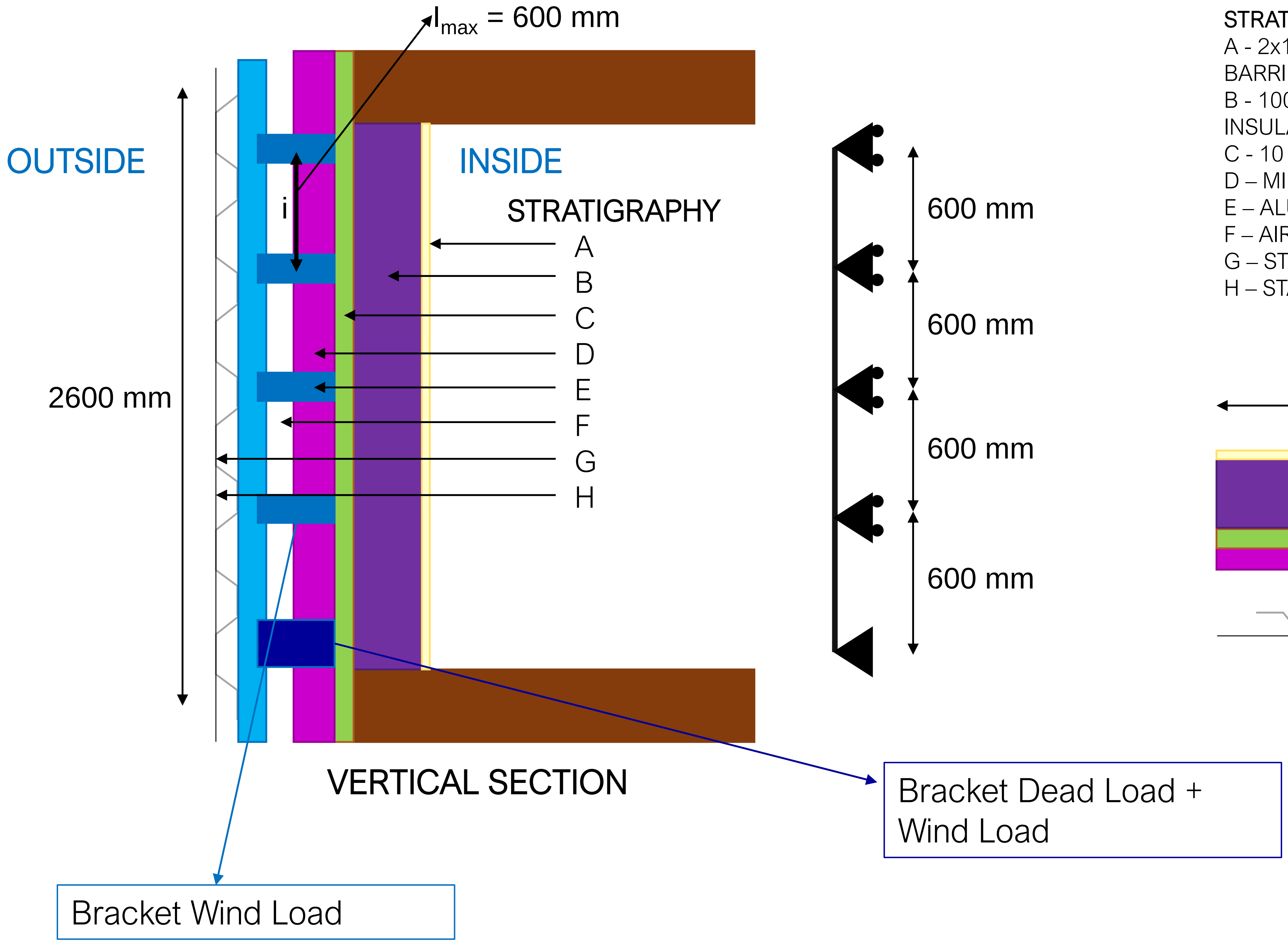
Please consider that the span shall follow the ctrs to ctrs of SFS Stud.

Span among L supports (metres) = 0.6 m

3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

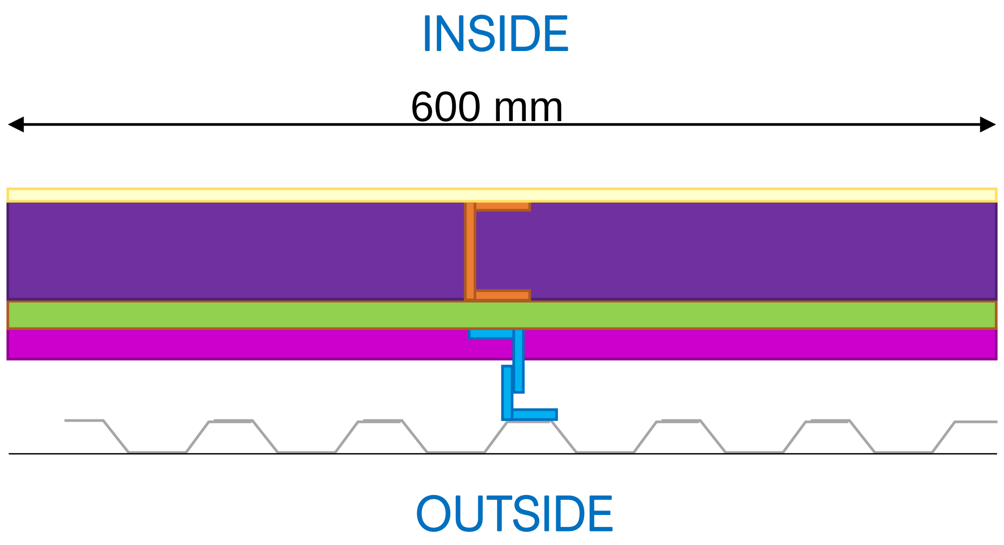
EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION
PROPOSAL 1 SUBSTRUCTURE (STATIC SCHEME)

Following is shown the static scheme considered for the verification of the supports (aluminium mullion, aluminium brackets and SFS Stud).
It has been considered the typical span between slabs (2600 mm).
The stratigraphy shown below is related at standing seam and corrugated sheet.



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 + PVC LAYER (1 MM)
F – AIR CAVITY
G – STEEL DECK 0.7MM
H – STANDING SEAM (NEW OR REUSED)



HORIZONTAL SECTION

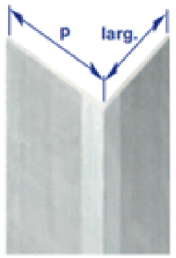
3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

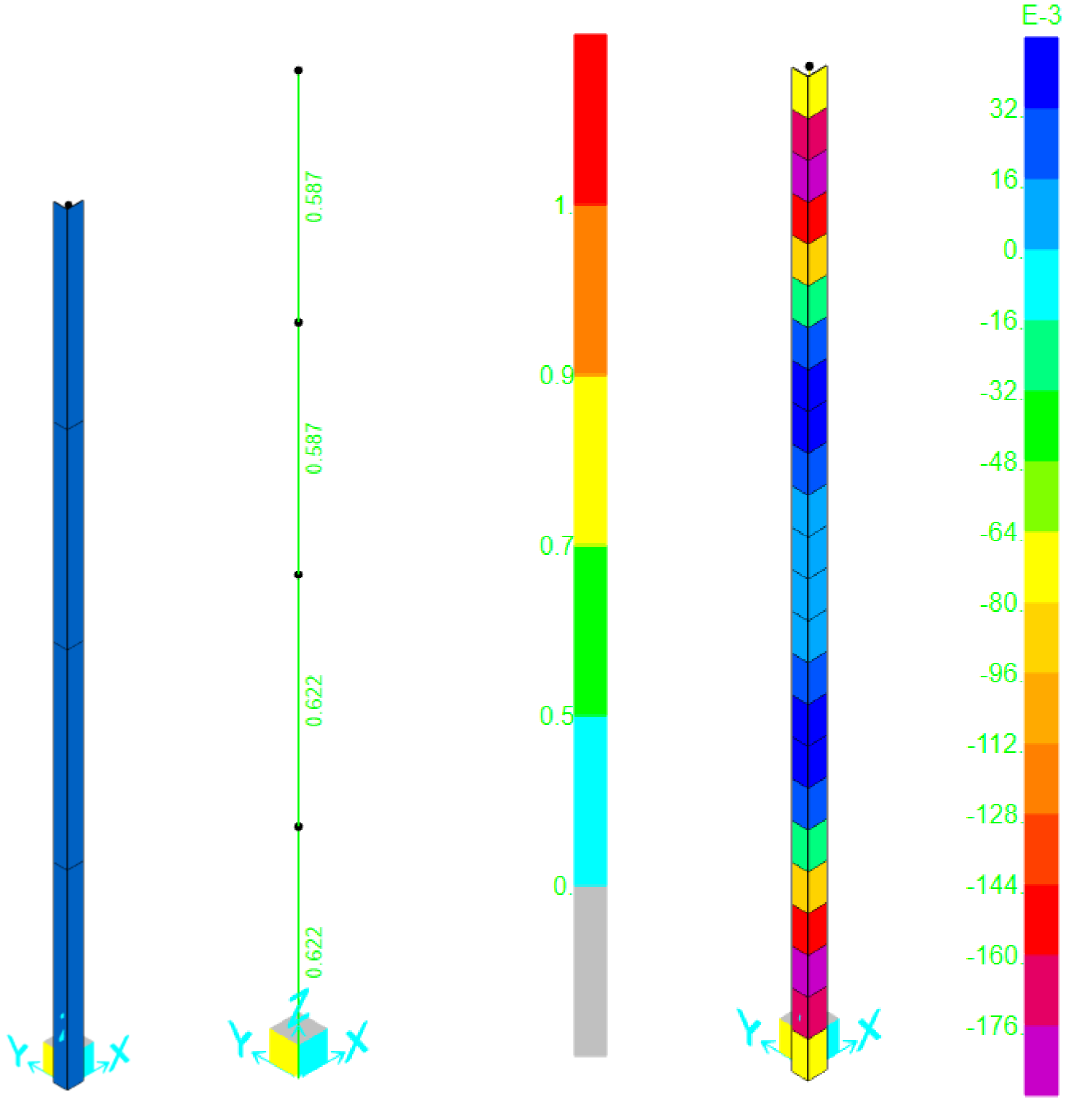
PROPOSAL 1 SUBSTRUCTURE (ALUMINIUM MULLION) (6060 T5; thk 2 mm)

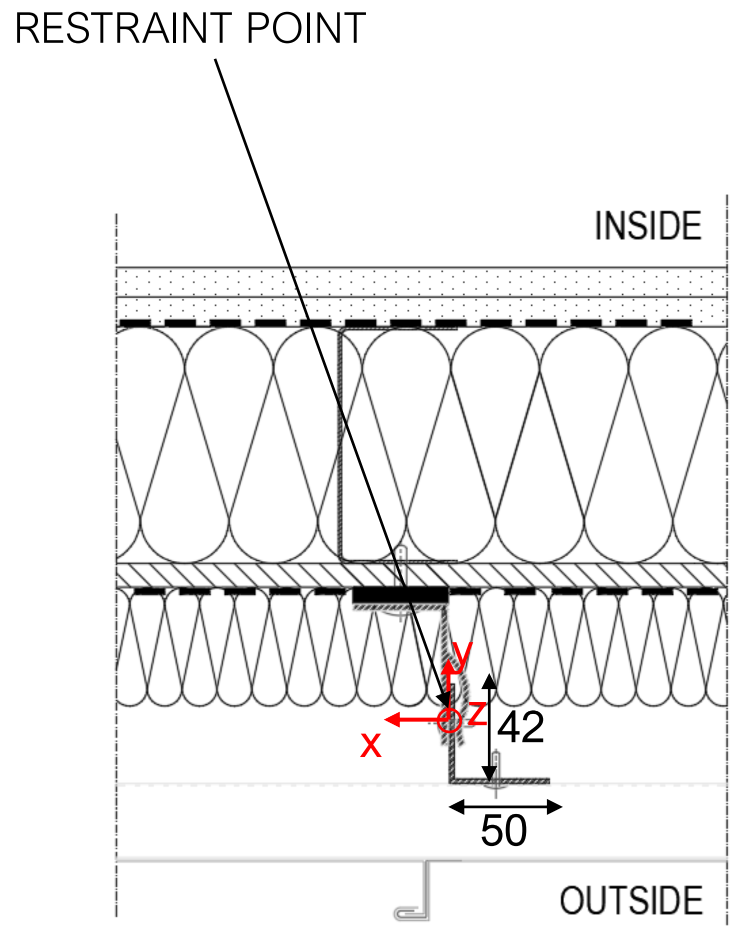
FOLLOWING, THE “L” ALUMINIUM MULLION CONSIDERED:

PROFIL ALUMINIUM POUR OSSATURE PRIMAIRE - LONGUEURS 3 OU 6 MÈTRES



			PROFIL FAÇALU L	
larg. x p	Ép.	Lg. (m)	Cond.	Code
50 x 42	2	3	1	611 036
50 x 42	2	6	1	611 016
50 x 42	2,5	3	1	611 049
50 x 42	2,5	6	1	611 047
50 x 50	3	6	1	667 135





Input Data:

Wind Load Suction:	P_{WLS}	=	-0.85 kPa
Wind Load Pressure:	P_{WLP}	=	0.7 KPa
Dead Load:	P_{DL}	=	0.12 kPa
Panel Width:	l	=	600 mm
Panel Height:	h	=	2600 mm
Connection Spacing:	i	=	600 mm

Section Properties Aluminum Mullion

The aluminum section is class 4.

Use aluminium EN AW 6060 T5 t ≤ 5mm

E_{al} = 70000MPa

f_o = 120MPa

f_u = 160MPa

γ_{M1} =1,10

σ_{adm} = f_o / γ_{M1} =109MPa

Max working ratio = 0.622 Check is OK

Max displacement = 0.176 mm Check is OK

CUMMING Building Value Through Expertise MAFFEIS engineering

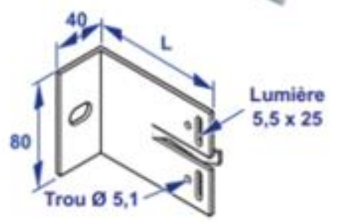
3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

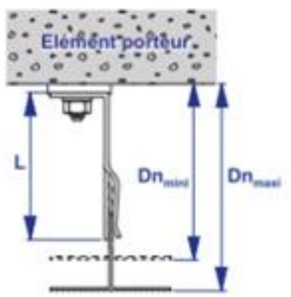
EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (ALUMINIUM BRACKETS) (6005A T6; thk 3 mm)

FOLLOWING, THE ALUMINIUM BRACKETS CONSIDERED:

<u>EWS-1-001</u>





			Équerre ISOLALU LR 80	
L	Dn mini *	Dn maxi *	Cond.	Code
40	63	68	100	611 000
60	73	98	100	611 001
80	93	118	100	611 002
100	113	138	100	611 003
120	133	158	100	611 004
140	153	178	50	611 005
160	173	198	50	611 006
180	193	218	50	611 068
200	213	238	50	611 069
220	233	258	50	611 071
240	253	278	50	611 141

(*) Dn mini / maxi avec cale Thermostop épaisseur 6 mm

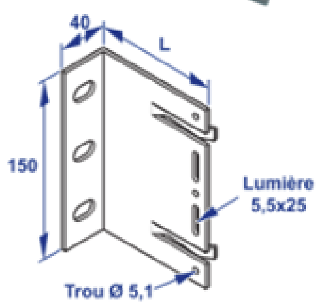
<u>Bracket Wind load</u>

<u>EWS-1-002</u>

			Équerre ISOLALU LR 80	
L	Dn mini *	Dn maxi *	Cond.	Code
40	63	68	100	611 000
60	73	98	100	611 001
80	93	118	100	611 002
100	113	138	100	611 003
120	133	158	100	611 004
140	153	178	50	611 005
160	173	198	50	611 006
180	193	218	50	611 068
200	213	238	50	611 069
220	233	258	50	611 071
240	253	278	50	611 141

(*) Dn mini / maxi avec cale Thermostop épaisseur 6 mm

<u>Bracket Wind load</u>



			Équerre ISOLALU LR 150	
L	Dn mini *	Dn maxi *	Cond.	Code
40	63	68	100	611 019
60	73	98	100	611 007
80	93	118	100	611 008
100	113	138	100	611 009
120	133	158	100	611 010
140	153	178	50	611 011
160	173	198	50	611 012
180	193	218	50	611 146
200	213	238	50	611 083
220	233	258	50	611 147
240	253	278	50	611 149

(*) Dn mini / maxi avec cale Thermostop épaisseur 6 mm

<u>Bracket Dead load + Wind load</u>

			Équerre ISOLALU LR 150	
L	Dn mini *	Dn maxi *	Cond.	Code
40	63	68	100	611 019
60	73	98	100	611 007
80	93	118	100	611 008
100	113	138	100	611 009
120	133	158	100	611 010
140	153	178	50	611 011
160	173	198	50	611 012
180	193	218	50	611 146
200	213	238	50	611 083
220	233	258	50	611 147
240	253	278	50	611 149

(*) Dn mini / maxi avec cale Thermostop épaisseur 6 mm

<u>Bracket Dead load + Wind load</u>

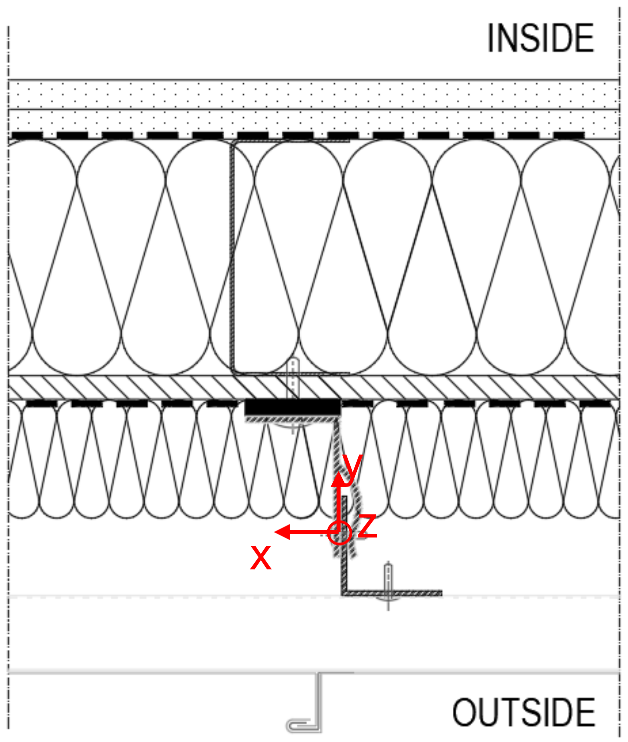
3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

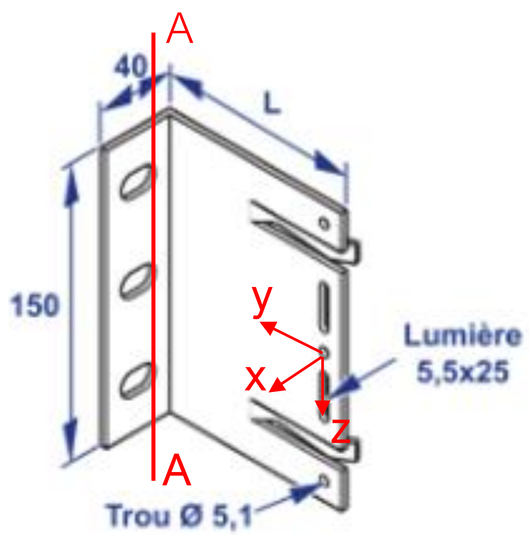
EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (ALUMINIUM BRACKETS)

For the verification of the brackets it has been considered the worst case which is the brackets with a 160 mm length.

<u>Bracket Dead Load + Wind Load</u>



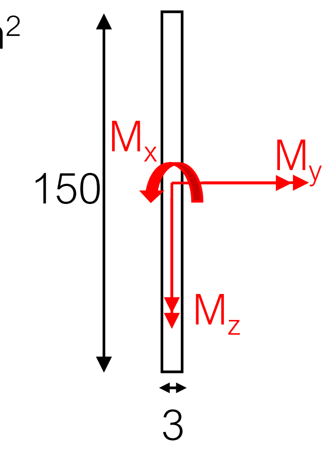


Area = 450 mm^2

a= 150 mm

b= 3 mm

Section A-A



Section Properties Aluminum Bracket

Use aluminium EN AW 6005A T6 t ≤ 5mm

E_{al} = 70000MPa

f_o = 225MPa

f_u = 270MPa

γ_{M1} =1,10

σ_{adm} = f_o / γ_{M1} = 205MPa

$Fy = 1.5 \cdot PWLS \cdot l \cdot i = 0.5kN$ Horizontal Force

$Fz = 1.35 \cdot P_{DL} \cdot h \cdot i = 0.3kN$ Vertical Force

$\mathrm{Mz} = Fy \cdot 20mm = 0.01\ kNm$

$\mathrm{My} = Fz \cdot 20mm = 0.006\ kNm$

$\mathrm{Mt} = Fz \cdot 160mm = 0.05\ kNm$

W_z=(150mm·(3mm)^2)/6 = 225 mm^3

W_y=(3mm·(150mm)^2)/6 = 11250 mm^3

σ_{Ed}=Mz/Wz + My/Wy = 45 MPa

τ_{Ed}=((3Mt)/(a b^2)) +($\sqrt{F_y^2 + F_z^2}$ / 0.8 A)= 112.7 MPa

σ_{max}=√(σ_{Ed}^2+3·τ_{Ed}^2)=200.4 Mpa

$$\frac{\sigma_{max}}{\sigma_{adm}} = 0.98$$

Check is OK

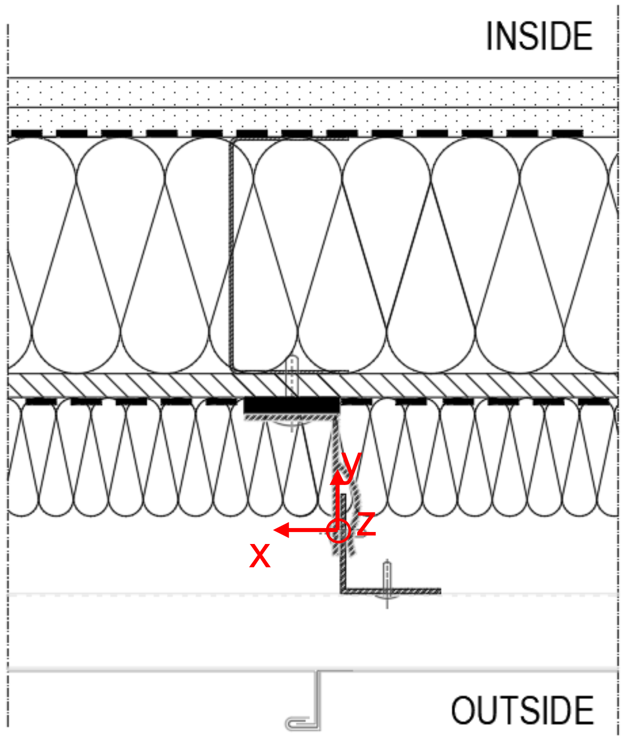
3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

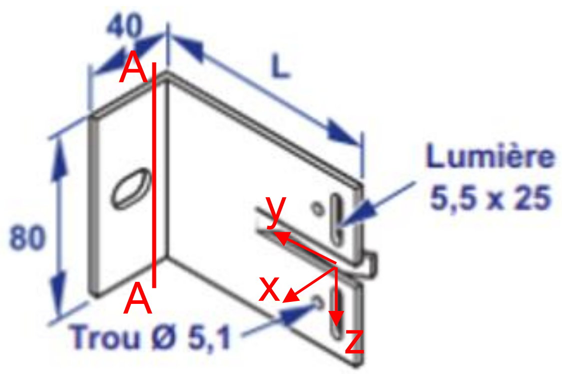
EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (ALUMINIUM BRACKETS)

For the verification of the brackets it has been considered the worst case which is the brackets with a 160 mm length.

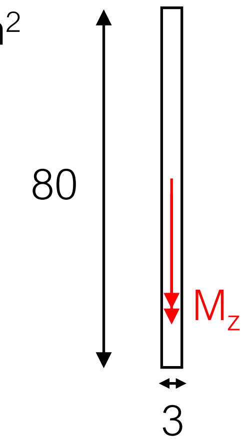
<u>Bracket Wind Load</u>





Section A-A

Area = 240 mm^2



Section Properties Aluminum Bracket

Use aluminium EN AW 6005A T6 t ≤ 5mm

E_{al} = 70000MPa

f_o = 225MPa

f_u = 270MPa

γ_{M1} =1,10

σ_{adm} = f_o / γ_{M1} =205MPa

$$Fy = 1.5 \cdot PWLS \cdot l \cdot i = 0.5kN$$

Horizontal Force

$$\mathrm{Mz} = Fy \cdot 20mm = 0.01\ kNm$$

$$\mathrm{W_z}=(80\mathrm{mm}\cdot(3\mathrm{mm})\text{^}2)/6 = 120\ \mathrm{mm}\text{^}3$$

$$\sigma_{\mathrm{Ed}}=\mathrm{Mz/Wz} \quad = 83\ \mathrm{MPa}$$

$$\tau_{\mathrm{Ed}}=Fy/\ 0.8\ \mathrm{A}= 3\ \mathrm{MPa}$$

$$\sigma_{\mathrm{max}}=\sqrt{}(\sigma_{\mathrm{Ed}}\text{^}2+3\cdot\tau_{\mathrm{Ed}}\text{^}2\ )=83\ \mathrm{Mpa}$$

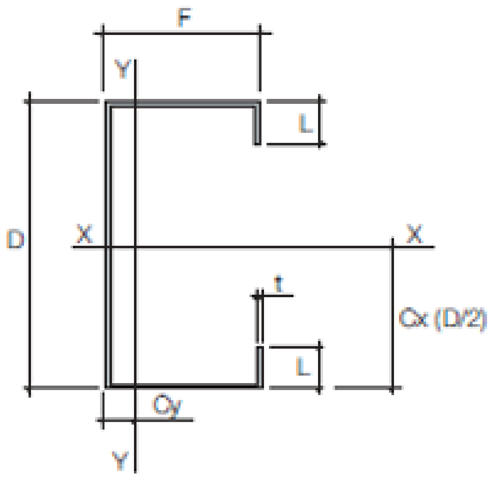
$$\frac{\sigma_{max}}{\sigma_{adm}} = 0.40$$

Check is OK

EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (SFS Stud)

The SFS Stud considered has the following characteristic:



'C sections': Used as studs in wall panels and joists in floor/roof panels.

D = 100 mm
F = 50 mm
L = 10 mm
t = 1.2 mm

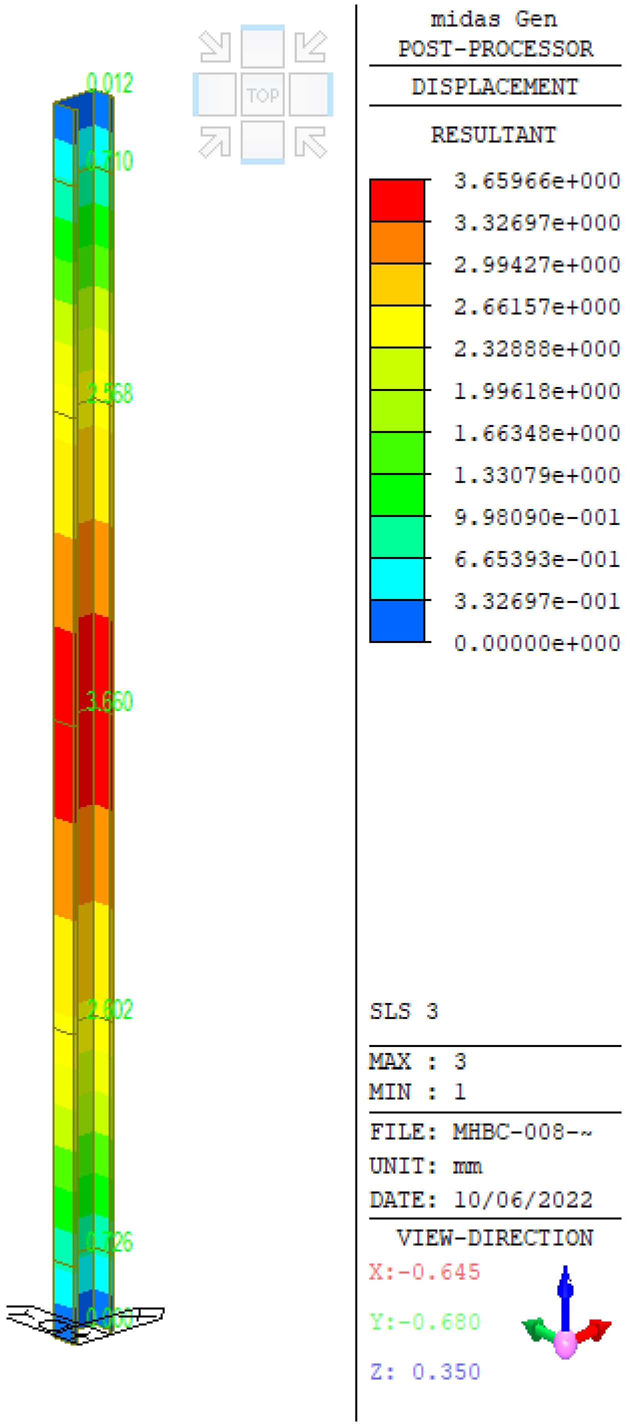
Section Properties SFS Stud

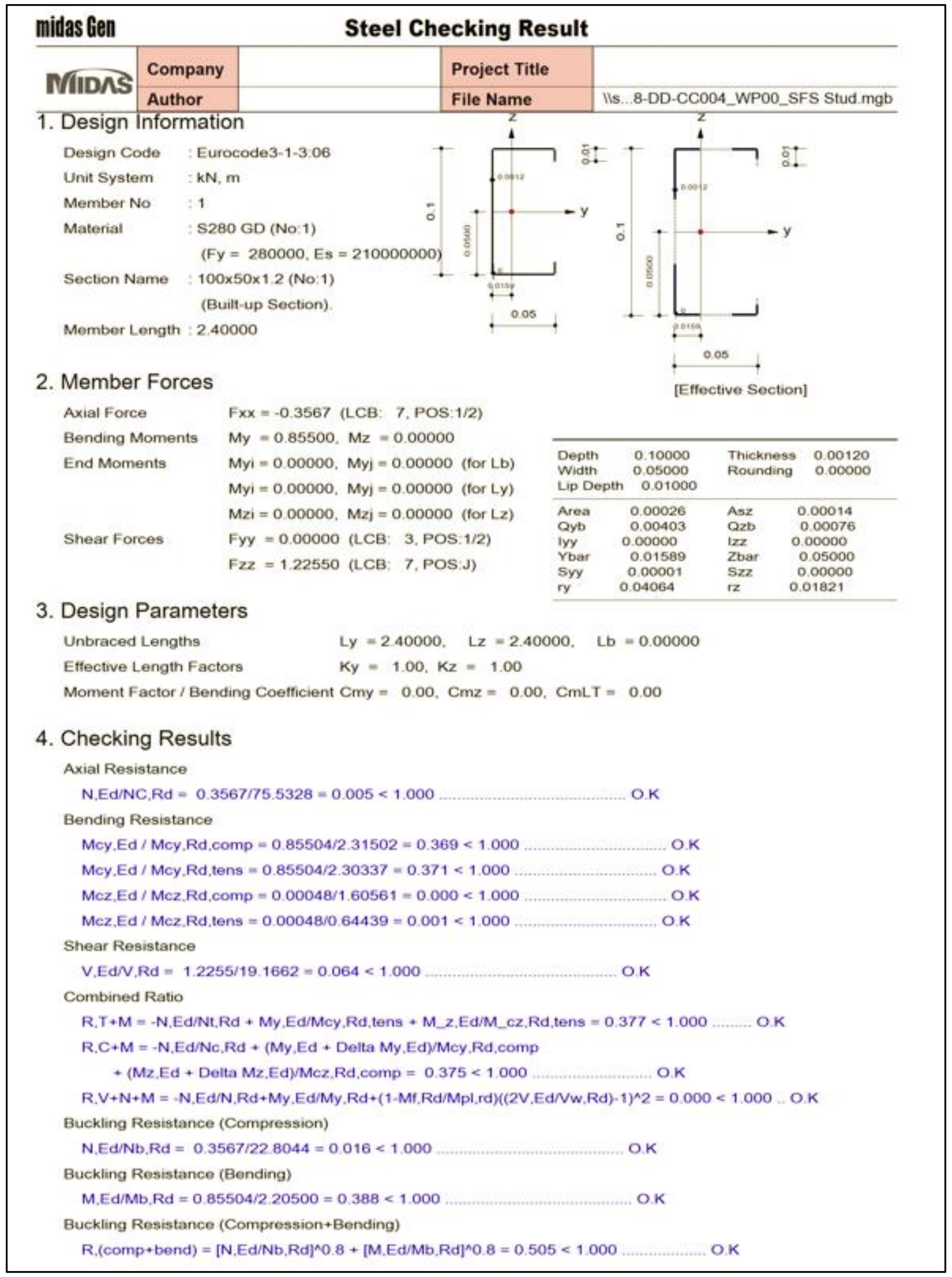
Since there is no data about the steel grade used, for the calculation we considered the usually worst grade for SFS

Grade S280GD (minimum yield strength = 280 N/mm^2)

E_{al} = 210000MPa
f_o = 120MPa
f_u = 360MPa
γ_{M1} = 1,00

σ_{adm} = 280MPa





midas Gen — **Steel Checking Result**

MIDAS	Company		Project Title	
	Author		File Name	\\s...8-DD-CC004_WP00_SFS Stud.mgb

1. Design Information

Design Code : Eurocode3-1-3:06
Unit System : kN, m
Member No : 1
Material : S280 GD (No:1)
(Fy = 280000, Es = 210000000)
Section Name : 100x50x1.2 (No:1)
(Built-up Section).
Member Length : 2.40000

[Effective Section]

2. Member Forces

Axial Force Fxx = -0.3567 (LCB: 7, POS:1/2)
Bending Moments My = 0.85500, Mz = 0.00000
End Moments Myi = 0.00000, Myj = 0.00000 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 3, POS:1/2)
Fzz = 1.22550 (LCB: 7, POS:J)

Depth	0.10000	Thickness	0.00120
Width	0.05000	Rounding	0.00000
Lip Depth	0.01000		
Area	0.00026	Asz	0.00014
Qyb	0.00403	Qzb	0.00076
Iyy	0.00000	Izz	0.00000
Ybar	0.01589	Zbar	0.05000
Syy	0.00001	Szz	0.00000
ry	0.04064	rz	0.01821

3. Design Parameters

Unbraced Lengths Ly = 2.40000, Lz = 2.40000, Lb = 0.00000
Effective Length Factors Ky = 1.00, Kz = 1.00
Moment Factor / Bending Coefficient Cmy = 0.00, Cmz = 0.00, CmLT = 0.00

4. Checking Results

Axial Resistance
N,Ed/NC,Rd = 0.3567/75.5328 = 0.005 < 1.000 .... O.K
Bending Resistance
Mcy,Ed / Mcy,Rd,comp = 0.85504/2.31502 = 0.369 < 1.000 .... O.K
Mcy,Ed / Mcy,Rd,tens = 0.85504/2.30337 = 0.371 < 1.000 .... O.K
Mcz,Ed / Mcz,Rd,comp = 0.00048/1.60561 = 0.000 < 1.000 .... O.K
Mcz,Ed / Mcz,Rd,tens = 0.00048/0.64439 = 0.001 < 1.000 .... O.K
Shear Resistance
V,Ed/V,Rd = 1.2255/19.1662 = 0.064 < 1.000 .... O.K
Combined Ratio
R,T+M = -N,Ed/Nt,Rd + My,Ed/Mcy,Rd,tens + M_z,Ed/M_cz,Rd,tens = 0.377 < 1.000 .... O.K
R,C+M = -N,Ed/Nc,Rd + (My,Ed + Delta My,Ed)/Mcy,Rd,comp
+ (Mz,Ed + Delta Mz,Ed)/Mcz,Rd,comp = 0.375 < 1.000 .... O.K
R,V+N+M = -N,Ed/N,Rd+My,Ed/My,Rd+(1-Mf,Rd/Mpl,rd)((2V,Ed/Vw,Rd)-1)^2 = 0.000 < 1.000 .. O.K
Buckling Resistance (Compression)
N,Ed/Nb,Rd = 0.3567/22.8044 = 0.016 < 1.000 .... O.K
Buckling Resistance (Bending)
M,Ed/Mb,Rd = 0.85504/2.20500 = 0.388 < 1.000 .... O.K
Buckling Resistance (Compression+Bending)
R,(comp+bend) = [N,Ed/Nb,Rd]^0.8 + [M,Ed/Mb,Rd]^0.8 = 0.505 < 1.000 .... O.K

δ_{max} = 3.66 mm < 2400 mm/360 = 6.7 mm **Check is OK**

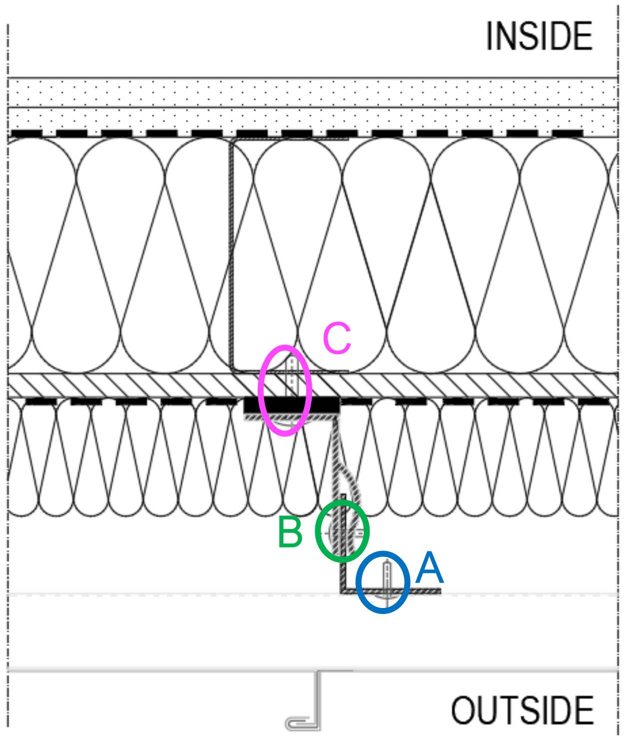
3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

EWS-1_001 - 002: 85 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (Screws)

Following are shown the calculation of screws:

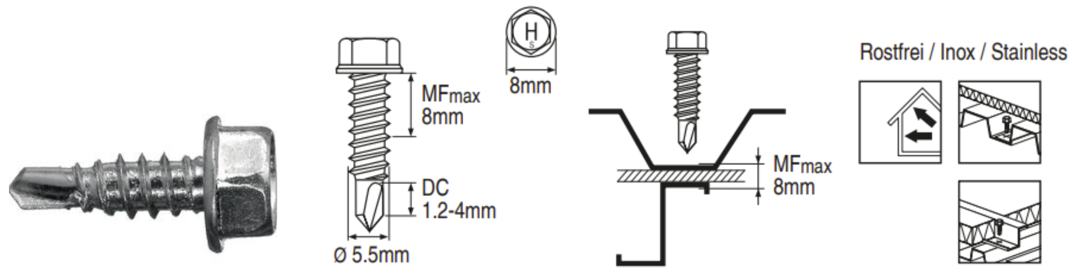
A) Screw between corrugated sheet and "L" aluminium mullion
B) Screw between "L" aluminium mullion and brackets
C) Screw between brackets and SFS Stud

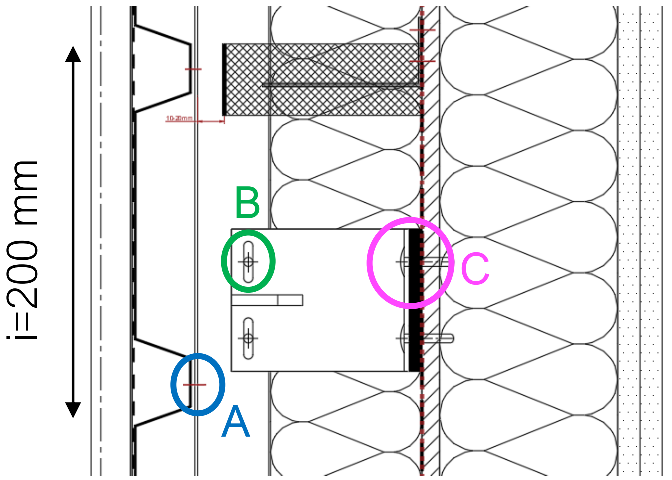


Check Screw A

n (approximately numbers of screws in panel height 2.6m) = 6

The screw shall have the following characteristics





$Ft = 1.5 \cdot PWLS \cdot l \cdot (i + i) = 0.31\ kN$ (force on single screw)

$Fv = \frac{1.35 \cdot PDL \cdot l \cdot h}{6} = \frac{0.3}{6} = 0.05\ kN$ (force on single screw)

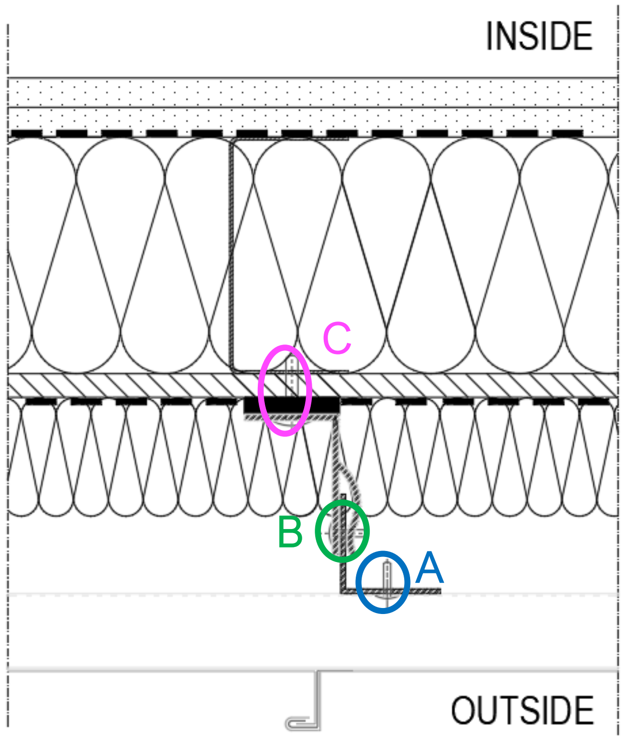
Screw connection design - Max shear strength - EN 1993-1-8				
Screw size, grade	ST 5.5	A-50		
Nominal diameter	d	5.28	mm	
Effective screw diameter	d_{2max}	4.17	mm	
Shear coefficient	α	0.50	-	
Ultimate tensile strength	f_{ub}	500.00	MPa	
Effective screw area	A	13.65	mm^2	
Safety factor	γ_{M2}	1.25	-	
Thread pitch	s	1.80	mm	
Shear strength per screw	$F_{v,Rd}$	**2.73**	**kN**	
Max tensile strength - EN 1993-1-8				
Screw head strength coefficient	k_2	0.90	-	
Tensile strength per screw	$F_{t,Rd}$	**4.91**	**kN**	
Shear and tension combined - EN 1993-1-8				
Design shear	$F_{v,Ed}$	0.05	kN	OK
Design axial load	$F_{t,Ed}$	0.31	kN	OK
Utilisation	U	**0.06**	-	OK
Bearing resistance - EN 1993-1-3				
Plate thickness - thinnest	t	0.70	mm	
Plate thickness - thickest	t_1	2.00	mm	
Plate ultimate strength	f_u	160.00	MPa	
Shear coefficient	α	2.10	-	
Bearing strength	$F_{b,Rd}$	**0.99**	**kN**	
Utilisation	U	**0.05**	-	OK
Pull through strength - EN 1993-1-3				
Diameter of head of screw or washer	d_w	8.00	mm	
Pull through strength (static loads)	$F_{p,Rd}$	**0.72**	**kN**	
Pull through strength (dynamic loads - wind)	$F_{p,Rd}$	**0.36**	**kN**	
Utilisation	U	**0.86**	-	OK
Pull out strength - EN 1993-1-3				
Support thickness	t_{sup}	2.00	mm	
Support ultimate strength	$f_{u,sup}$	160.00	MPa	
Pull out strength	$F_{o,Rd}$	**0.88**	**kN**	
Utilisation	U	**0.35**	-	OK

EWS-1_001 - 002: 50 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (Screws)

Following are shown the calculation of screws:

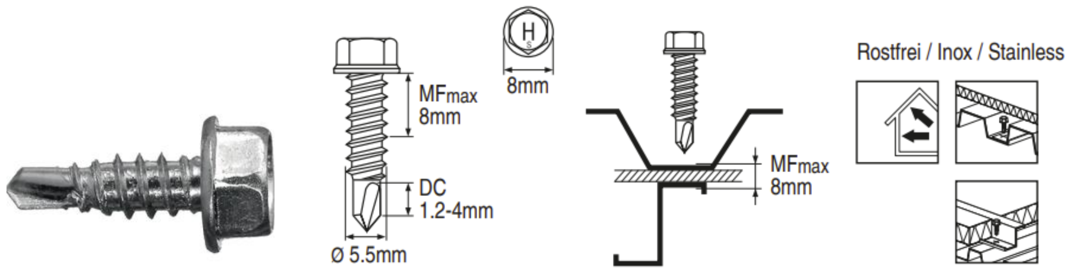
A) Screw between corrugated sheet and "L" aluminium mullion
B) Screw between "L" aluminium mullion and brackets
C) Screw between brackets and SFS Stud

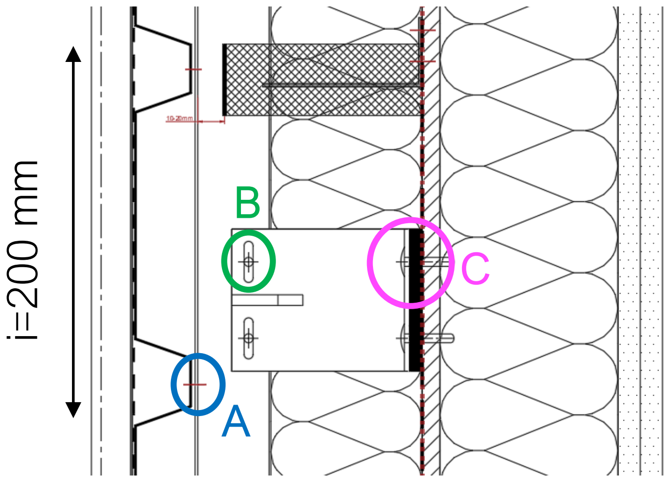


<u>Check Screw B (wind load bracket – worst case)</u>

n (numbers of screws in wind load bracket) = 2

The screw shall have the following characteristics





$Ft = (1.5 \cdot PWLS \cdot l \cdot i)/2 = 0.25\ kN$ (force on single screw)

Screw connection design - Max shear strength - EN 1993-1-8				
Screw size, grade	ST 5.5	A-50		
Nominal diameter	d	5.28	mm	
Effective screw diameter	d_{2max}	4.17	mm	
Shear coefficient	α	0.50	-	
Ultimate tensile strength	f_{ub}	500.00	MPa	
Effective screw area	A	13.65	mm^2	
Safety factor	γ_{M2}	1.25	-	
Thread pitch	s	1.80	mm	
Shear strength per screw	**$F_{v,Rd}$**	**2.73**	**kN**	
Max tensile strength - EN 1993-1-8				
Screw head strength coefficient	k_2	0.90	-	
Tensile strength per screw	**$F_{t,Rd}$**	**4.91**	**kN**	
Shear and tension combined - EN 1993-1-8				
Design shear	$F_{v,Ed}$	0.25	kN	OK
Design axial load	$F_{t,Ed}$	0.00	kN	OK
Utilisation	**U**	**0.09**	-	OK
Bearing resistance - EN 1993-1-3				
Plate thickness - thinnest	t	2.00	mm	
Plate thickness - thickest	t_1	3.00	mm	
Plate ultimate strength	f_u	160.00	MPa	
Shear coefficient	α	2.10	-	
Bearing strength	**$F_{b,Rd}$**	**2.84**	**kN**	
Utilisation	**U**	**0.09**	-	OK
Pull through strength - EN 1993-1-3				
Diameter of head of screw or washer	d_w	8.00	mm	
Pull through strength (static loads)	**$F_{p,Rd}$**	**2.05**	**kN**	
Pull through strength (dynamic loads - wind)	**$F_{p,Rd}$**	**1.02**	**kN**	
Utilisation	**U**	**0.00**	-	OK
Pull out strength - EN 1993-1-3				
Support thickness	t_{sup}	2.00	mm	
Support ultimate strength	$f_{u,sup}$	160.00	MPa	
Pull out strength	**$F_{o,Rd}$**	**0.88**	**kN**	
Utilisation	**U**	**0.00**	-	OK

CUMMING Building Value Through Expertise MAFFEIS engineering

3. EWS-1: COPPER OR ZINC STANDING SEAM PANEL

EWS-1_001 - 002: 50 - 100 mm OUTER INSULATION

PROPOSAL 1 SUBSTRUCTURE (Screws)

Following are shown the calculation of screws:

A) Screw between corrugated sheet and "L" aluminium mullion
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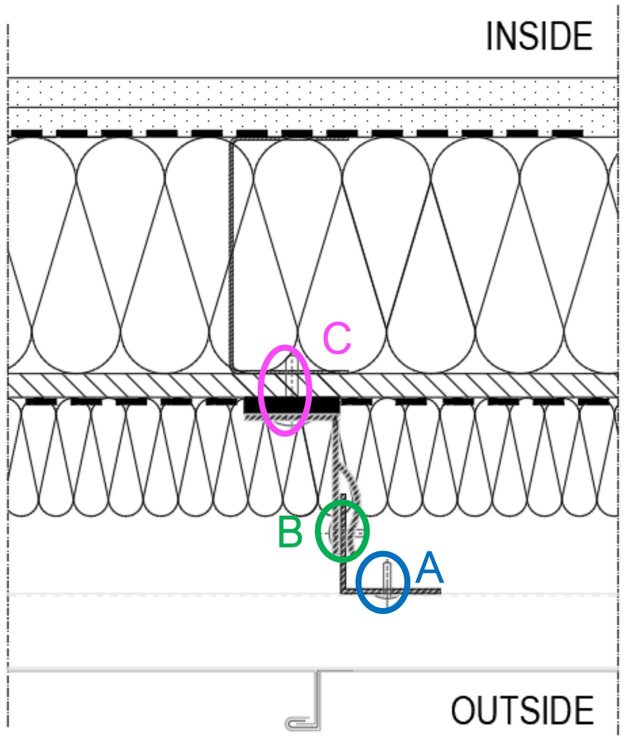
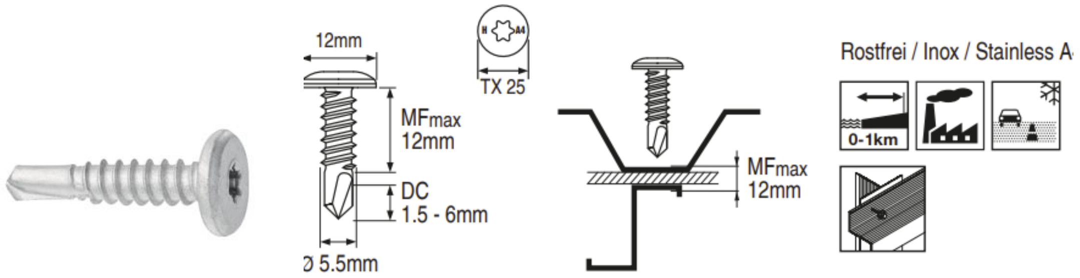
C) Screw between brackets and SFS Stud

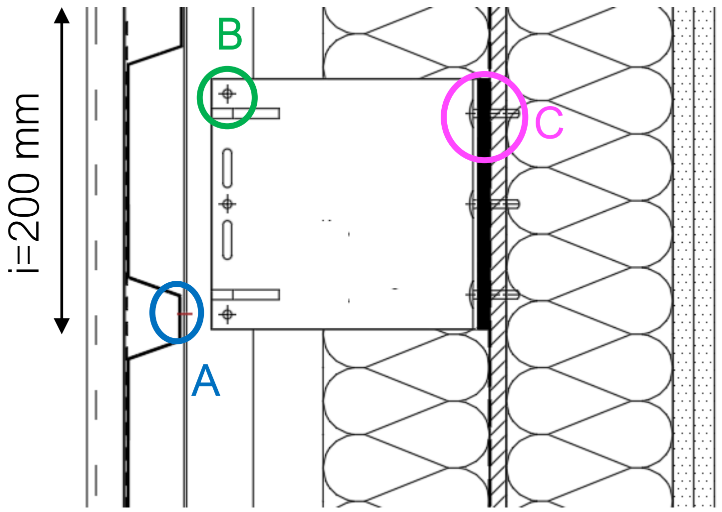


Check Screw C (dead load + wind load bracket – worst case)

n (numbers of screws in wind load bracket) = 3

The screw shall have the following characteristics





$Fv = 0.2\ kN$ (force on single screw)
$Ft = 0.8\ kN$ (force on single screw)

Screw connection design - Max shear strength - EN 1993-1-8				
Screw size, grade	ST 5.5	A-50		
Nominal diameter	d	5.28	mm	
Effective screw diameter	d_{2max}	4.17	mm	
Shear coefficient	α	0.50	-	
Ultimate tensile strength	f_{ub}	500.00	MPa	
Effective screw area	A	13.65	mm²	
Safety factor	γ_{M2}	1.25	-	
Thread pitch	s	1.80	mm	
Shear strength per screw	$F_{v,Rd}$	**2.73**	**kN**	
Max tensile strength - EN 1993-1-8				
Screw head strength coefficient	k_2	0.90	-	
Tensile strength per screw	$F_{t,Rd}$	**4.91**	**kN**	
Shear and tension combined - EN 1993-1-8				
Design shear	$F_{v,Ed}$	0.20	kN	OK
Design axial load	$F_{t,Ed}$	0.80	kN	OK
Utilisation	U	**0.19**	-	OK
Bearing resistance - EN 1993-1-3				
Plate thickness - thinnest	t	1.20	mm	
Plate thickness - thickest	t_1	3.00	mm	
Plate ultimate strength	f_u	160.00	MPa	
Shear coefficient	α	2.10	-	
Bearing strength	$F_{b,Rd}$	**1.70**	**kN**	
Utilisation	U	**0.12**	-	OK
Pull through strength - EN 1993-1-3				
Diameter of head of screw or washer	d_w	12.00	mm	
Pull through strength (static loads)	$F_{p,Rd}$	**1.84**	**kN**	
Pull through strength (dynamic loads - wind)	$F_{p,Rd}$	**0.92**	**kN**	
Utilisation	U	**0.87**	-	OK
Pull out strength - EN 1993-1-3				
Support thickness	t_{sup}	1.20	mm	
Support ultimate strength	$f_{u,sup}$	360.00	MPa	
Pull out strength	$F_{o,Rd}$	**0.82**	**kN**	
Utilisation	U	**0.97**	-	OK

4. 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.

Scope of this document is to investigate the solution already provided in RIBA STAGE 3 report and check their feasibility in terms of loads involved and structural analysis.

Since the layers within the proposed solutions of EWS-2 and EWS-3 do not involve a relevant change in terms of weights to the SFS system (considering to have a max distance between SFS Stud equal to 600 mm) it was reported only the stability checks of the EWS-1.

The structural performance of the solution proposed for the EWS-1 has been analysed and reported in this document. The solution is feasible in terms of loads involved, and do not affect the stability of the SFS system already installed.