THERMAL PERFORMANCE CALCULATION

Analysis Undertaken and Report

Prepared by Façade Creations

Document Title: U value analysis of rainscreen backing wall

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Revisions and Essential Declarations

Revision Status

The current status of this document is Rev 01, representing the Initial issue of the thermal analysis report, dated xx xx xxxx

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Defined Scope of Assessment

It is paramount to note that this document is dedicated exclusively to providing an assessment of the thermal performance only of the system.

This analysis does not, and is not intended to, cover or contain any assessments regarding the façade’s suitability for other critical aspects of building performance, including but not limited to, structural integrity and fire resistance. Comprehensive assessment of these areas remains the responsibility of the client and their nominated specialist engineers.

Summary of Thermal Performance Analysis

This document presents the findings from a 3-dimensional thermal finite element analysis performed on the rainscreen backing wall system. This analysis was conducted to establish the critical U-value performance data required for the XXXXXX project, located in XXXXX, on behalf of https://www.facadecreations.co.uk/.

System Description and Methodology

The wall construction under investigation comprises a ventilated rainscreen system supported by vertical rails and an array of helping hand brackets, all fixed back to a supporting SFS (Steel Frame System) wall.

- **Governing Standard:** By convention, and referencing BR443, the external rainscreen element itself is not included in the primary U-value calculation. However, a crucial amendment is made to the external surface resistance of the insulating material to accurately account for the sheltering effect provided by the rainscreen cladding.
- **Thermal Bridging:** Crucially, the thermal impact of penetrating brackets that pass through the insulation layer must be allowed for and rigorously accounted for in the analysis. (See analysis notes for further details.)
- **Model Dimensions:** The nominal construction, as defined on drawing XXXXX and XX, was modelled as a representative sample area of 600mm (SFS module) by 2850mm (storey height).

Construction Build-Up (From Exterior to Interior)

The modelled assembly includes the following material layers and components:

1. **Insulation:** 190mm Rockwool DuoSlab mineral wool insulation ($\lambda = 0.035 \text{ W/mK}$) installed within the cavity behind the rainscreen.
2. **Membrane/Sheathing:** A Tyvek Firecurb breather membrane covering a 15mm CP sheathing board, fixed to the SFS wall.
3. **SFS Structure:** 150mm uninsulated SFS framework spaced at 600mm centres.
4. **Internal Finishes:** An assumed two layers of 15mm plasterboard with a VCL (Vapour Control Layer) forming the internal finish.

Bracket Detailing and Thermal Bridges

The thermal bridges introduced by the support system were modelled with precision:

- **Helping Hand Brackets:** Sized as 75mm long for restraint (single bracket) and 150mm long for load-bearing (double bracket). The module height includes four single and one double bracket.

- **Fixing System:** The brackets are secured to the SFS via a 3mm aluminium channel section (100mm deep at single brackets and 170mm deep at double bracket locations).

- **Isolation:** A 5mm thick isolating pad has been included between the bracket and the horizontal rail for thermal break purposes.

- **Vertical Supports:** The vertical cladding supports that penetrate the cavity insulation have been explicitly included in this finite element analysis.

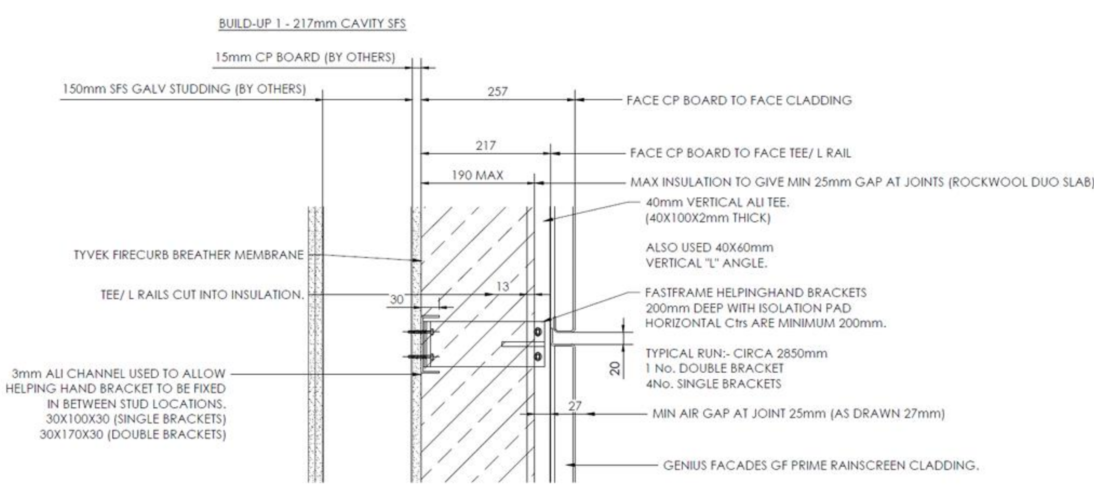
Performance Results

The detailed analysis of the examined area yields the following critical performance data:

- **Achieved U-value:** The construction achieves an overall thermal transmittance value of **0.41 W/m²K .**

- **Condensation Risk:** A comprehensive condensation risk analysis, performed in accordance with BS EN ISO 13788:2002, conclusively demonstrates that no condensation will occur within the construction assessed.

Wall section detail (extract XXXXX)



Wall U-Value Calculation: Detailed Analysis

The effective U-value of the rainscreen backing wall is determined by summing the heat transfer contributions from the nominal wall construction and the linear/point thermal bridging elements (rails and brackets) within the modelled section.

Calculated Thermal Performance Breakdown

Wall Dimensions: 0.6 m x 2.850 m
Horizontal Bracket Centers: 600 mm

Component	Description	U / X / Ψ Value (W/m²K, W/K, or W/mK)	Area (m²)	Length (m)	Qty	Q (W/K)
Nominal wall	U-value	0.175	1.710	–	–	0.299
Load bracket	X-value	0.115	–	–	1	0.115
Load rail	Ψ-value	0.003	–	0.600	1	0.002
Wind bracket	X-value	0.071	–	–	4	0.284
Wind rail	Ψ-value	0.003	–	0.600	4	0.007
Vertical rail	Ψ-value	0.000	–	3.000	1	0.000

Totals:

- Area: 1.710 m²
- Total heat loss (Q): 0.707 W/K

U-Value Summary

Effective U-Value: 0.41 W/m²K

Calculation Method

The effective U-value is determined by summing the heat losses from:

- The nominal wall construction (Nominal U-value × Area), and
- The penetrating elements such as brackets and rails (X × Quantity and Ψ × Length).

The total heat transfer (W/K) is then divided by the wall area (m²) to yield the resulting effective U-value.

3D Thermal Analysis Method

The thermal performance assessment for façade systems was conducted using TRISCO ver. 15.0.01**,** a three-dimensional finite element analysis software developed by Physibel. This advanced tool enables steady-state thermal simulations, ensuring consistent and precise evaluation of heat transfer through complex building envelope assemblies.

TRISCO facilitates detailed modeling of three-dimensional rectangular elements composed of various materials subjected to differing boundary conditions. The model geometry is defined through a series of rectangular blocks aligned to a structured grid, with each element assigned material properties and surface boundary conditions represented by distinct color codes. Fixed temperature or heat power boundary conditions can be applied to nodal points or at interfaces between materials, ensuring accurate representation of real-world thermal behaviors.

Once the geometry and material parameters are defined, TRISCO applies an energy balance technique to establish a system of linear equations, which is solved iteratively for optimum accuracy. Any nonlinear thermal interactions are addressed through successive computational cycles using adjusted linear systems.

For enhanced precision, simulations integrate Physibel's RADCON module**,** which refines infrared radiation and convective heat transfer analysis. This module accounts for surface emissivity, temperature variations, and empirical convection correlations - providing a more realistic representation of energy transfer within the façade assembly.

Material thermal conductivity values (λ-values) used in this analysis are sourced from BS EN 12524:2000**,** BS EN ISO 10077-2:2003**,** or the Physibel material database**.** Where applicable, manufacturer-specific data has been referenced for materials not explicitly covered under these standards.

The software automatically determines equivalent thermal conductivities for both ventilated and unventilated air cavities, ensuring comprehensive assessment of all façade components.

All analyses are conducted under steady-state conditions**,** excluding the influence of thermal mass or time-dependent effects from surrounding structures or materials.

Analysis Output

Data derived from the 3D thermal simulations provides detailed insights into the thermal behavior of each façade assembly. The analysis output includes the following components:

- **Material conductivity diagrams** illustrating assigned thermal conductivity values for each component, including software-generated equivalent cavity values where applicable.
- **Thermal gradient diagrams** displaying temperature distribution across the evaluated construction.

- **Material build-up data files** containing coordinates and configuration details of the modeled elements.
- **Thermal performance text output** summarizing the resulting temperature ranges, calculated **U-value** through the examined build-up, and **temperature factor (fRsi)** indicating the internal relative humidity level at which surface condensation may occur.

Please note that full 3D analyses have been performed for all elements using three insulation thickness options. However, to maintain file efficiency, only visual results for the **100 mm insulation option** are included within this document.

Reference – BR 443: Rainscreen Cladding

According to guidance from BR 443 (Building Research Establishment Report)**,** no allowance is made in U-value calculations for the rainscreen cladding itself, as the cavity behind is considered fully ventilated. However, the influence of support brackets and rails penetrating the insulation layer must be considered, as these elements significantly impact the overall U-value - even when thermal break pads are incorporated.

The calculation model should exclude the external cladding panels but must include the fixing brackets or rails in full to accurately represent their thermal bridging effect. The **external surface resistance** is taken as 0.13 m²K/W, rather than 0.04 m²K/W, to account for the sheltering influence of the rainscreen system.

For further technical guidance, reference should be made to the CAB/CWCT Design Guide for rainscreen cladding performance and compliance.

"Centre" U-Value (Excluding Brackets) and Condensation Risk Analysis

The **nominal U-value** of the façade construction, excluding the effect of support brackets, is calculated as **0.18 W/m²K**.

A **condensation risk assessment**, carried out in accordance with **BS EN ISO 13788:2012**, confirms that **no risk of interstitial condensation** is expected within the assessed construction. The analysis considers the full thermal behavior of the build-up, accounting for material properties, vapor resistances, and environmental conditions.

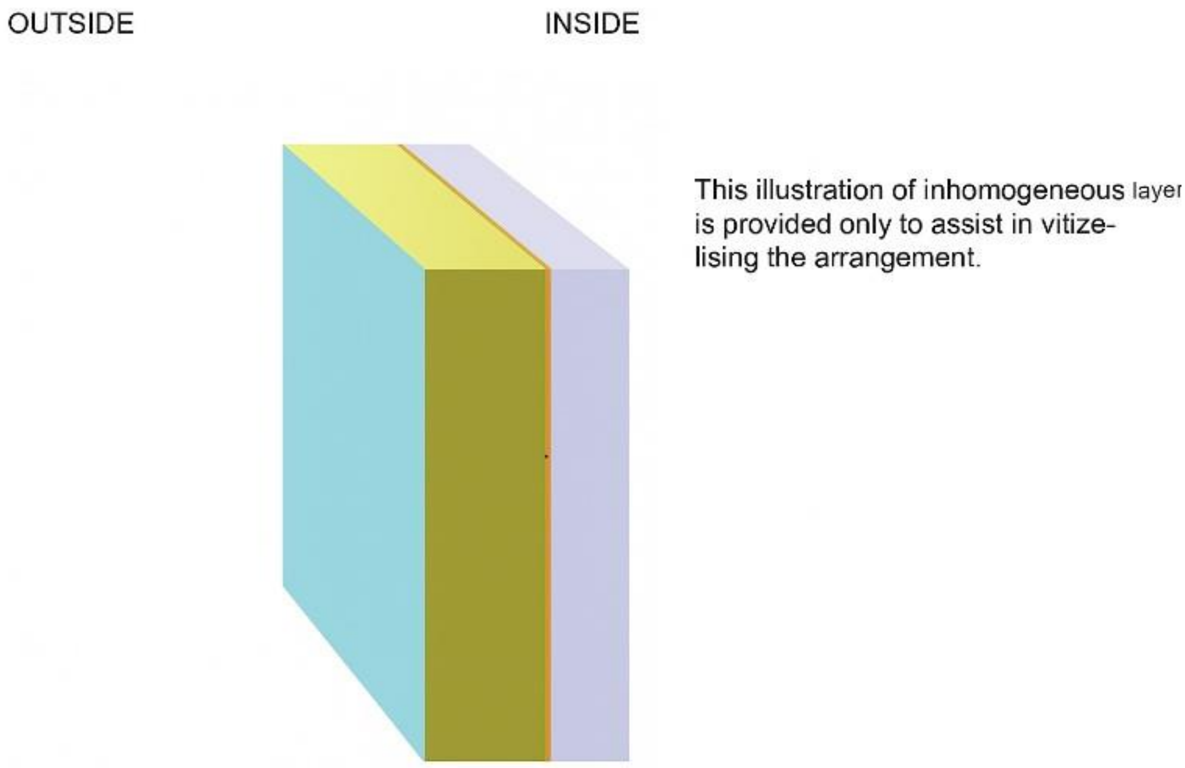
As the **rainscreen cladding cavity** is classified as *well-ventilated*, layers beyond this cavity have been excluded from the condensation analysis results, in line with standard practice and BRE guidance.

Temperature data used in the **BS EN ISO 13788** calculation is derived from **Met Office historical datasets**, representing mean monthly external and internal temperature profiles averaged over a **10-year period** to ensure a robust and representative evaluation of thermal performance under typical UK climate conditions.

Component Documentation

Thermal Transmittance (U-Value): Calculated in accordance with *BRE Digest 465*
Source: Façade Creations Technical Catalogue – External Wall Systems
Component: Aluminum-Framed Rainscreen Wall Assembly
Software Used: BuildDesk 3.4.6

This documentation outlines the calculation parameters and material composition used to determine the overall thermal transmittance of the specified façade wall system. The illustration of inhomogeneous layers is provided for visualization purposes only.



Assignment: External Wall

No.	Material / Reference Standard	Thickness (m)	Thermal Conductivity λ [W/mK]	Thermal Resistance R [m²K/W]
Rse	External Surface Resistance	—	—	0.1300
1	Aluminum Alloy (BS EN 12524)	0.0030	160.000	0.0000
2	Well-Ventilated Air Layer (BS EN ISO 6946)	0.0670	—	0.000

No.	Material / Reference Standard	Thickness (m)	Thermal Conductivity λ [W/mK]	Thermal Resistance R [m²K/W]
3	Façade Creations Insulation – Mineral Wool Core (based on Rockwool Duo-Slab)	0.1900	0.035	5.4286
4	Stainless Steel Insulation Fixings (1.5/m²)	—	—	—
5	Tyvek® Fire-Resistant Membrane (DuPont)	0.0002	0.500	0.0004
6	Cement-Bonded Particle Board (BS EN 12524)	0.0150	0.230	0.0652
7	Light Steel Frame Assembly	0.1500	—	0.1581
8	Polyethylene Vapor Barrier (BS EN 12524)	0.0002	0.170	0.0009
9	Gyproc FireLine (British Gypsum) – Inner Lining	0.0300 (2×15 mm)	0.240	0.1250
Rsi	Internal Surface Resistance	—	—	0.1300

Calculated Total Thermal Resistance (RT): 6.06 m²K/W
Corrections Applied (per Digest 465):

- Mechanical fasteners: ΔU = 0.0022 W/m²K
- Air gaps (BS EN ISO 6946 Annex F): ΔU = 0.0080 W/m²K
  Total Correction: 0.0102 W/m²K

Final U-Value:
U = (1 / RT) + ΔU = **0.18 W/m²K**

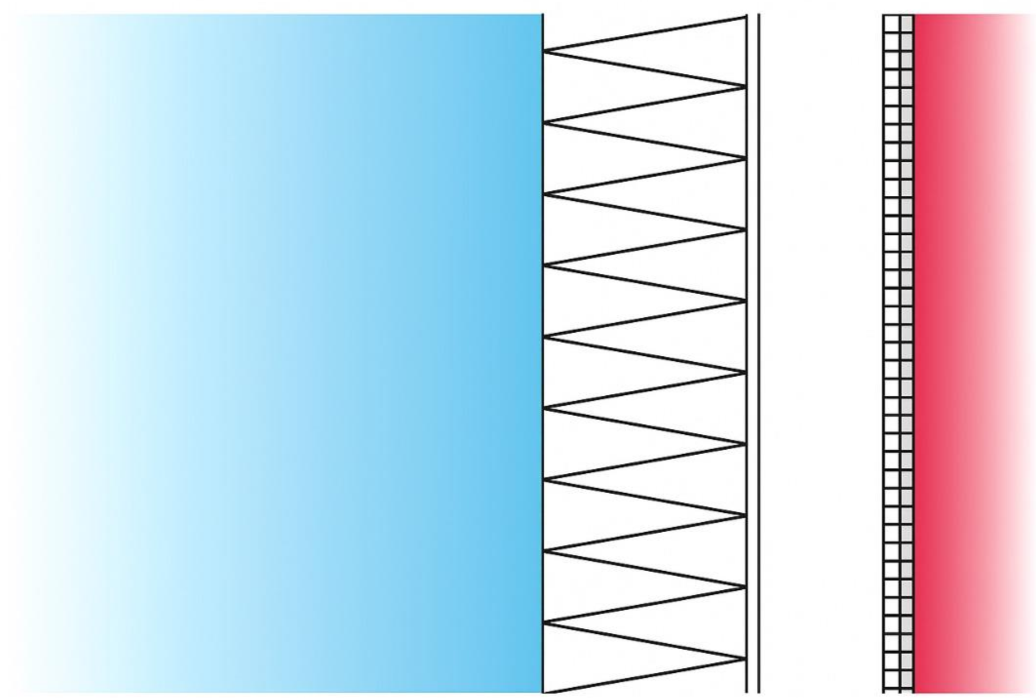
All material thermal properties are referenced from **BS EN 12524**, **BS EN ISO 6946**, or manufacturer-certified data. Data quality aligns with BuildDesk classifications:

- **A:** Verified and continuously tested by third party
- **B:** Manufacturer data certified by third party
- **C:** Manufacturer-validated data
- **D:** General database values (BuildDesk)
- **E:** User-input data

Compliance Benchmark: U_{max} = 0.30 W/m²K
Result: U = 0.18 W/m²K – *Compliant*

Documentation of the Component

Thermal Transmittance (U-value) according to *Digest 465*
Source: Façade Creations Technical Catalogue – External Walls
Component: External Wall System
Calculated with: BuildDesk 3.4.6



Parameter	Description / Value
Standard Referenced	Thermal Transmittance (U-value) according to *Digest 465*
Source	Façade Creations Technical Catalogue – External Walls

Parameter	Description / Value
Component	External Wall System
Software Used	BuildDesk 3.4.6
Steel Percentage	0.25%

Light Steel Frame Sections

Section	Portion (%)	Consisting of Material Layers
A	99.75%	Layers 3, 4, 5, 6a, 7, 8, 9
B	0.25%	Layers 3, 4, 5, 6b, 7, 8, 9

Thermal Transfer Resistance – Upper Limit

Parameter	Formula	Result
UA [W/(m²K)]	(Ri,A) + Rsi + Rse = 5.80 + 0.13 + 0.13	0.16
UB [W/(m²K)]	(Ri,B) + Rsi + Rse = 5.62 + 0.13 + 0.13	0.17
RT'	A × UA + B × UB	6.06 m²K/W

Thermal Transfer Resistance – Lower Limit

Layer	Formula	Result (m²K/W)
Rse	Fixed	0.13
R3"	d_3 / λ_3 = 0.1900 / 0.035	5.43
R4"	d_4 / λ_4 = 0.0002 / 0.500	0.00
R5"	d_5 / λ_5 = 0.0150 / 0.230	0.07
R6"	$d_6 / (\lambda_6a \times A + \lambda_6b \times B)$ = 0.1500 / (0.826 × 99.75% + 50.000 × 0.25%)	0.16
R7"	d_7 / λ_7 = 0.0002 / 0.170	0.00
R8"	d_8 / λ_8 = 0.0150 / 0.240	0.06
R9"	d_9 / λ_9 = 0.0150 / 0.240	0.06

Layer	Formula	Result (m^2K/W)
Rsi	Fixed	0.13
RT''	Ri'' + Rsi + Rse	**6.04 m^2K/W**

Frame Details

Parameter	Value
Kind of Frame	Hybrid Frame
Flange Width	Not exceeding 50 mm
Stud Spacing (s)	0.600 m
Stud Depth (d)	0.150 m
Web Thickness (t)	0.00150 m
Steel Percentage	0.25%

Weight Factor & Final Result

Parameter	Formula / Calculation	Result
Weight Factor (p)	$p = 0.8 \times (RT'' / RT') + 0.32 – 0.2 \times (0.6 / s) – 0.04 \times (d / 0.1)$	0.857
Final Thermal Resistance (RT)	$RT = p \times RT' + (1 – p) \times RT''$	**6.06 m^2K/W**

Documentation of the Component

Calculation Standard: BS EN ISO 13788
Source: Façade Creations – External Wall Catalogue
Component: Façade Creations Wall System 1
Software Used: BuildDesk 3.4.6

Overview

This condensation risk analysis has been carried out in accordance with **BS EN ISO 13788:2012** for a wall system featuring inhomogeneous layers. The results are specific to the selected section of the construction. For a comprehensive evaluation, it is recommended to perform additional calculations at alternative positions in accordance with **BS 5250:2021 – Management of Moisture in Buildings**.

Please note that the list of material layers below may differ from those used in the U-value calculation printout, as only layers relevant to the condensation risk analysis are included.

Assignment: External Wall

Name	Thickness [m]	λ [W/(mK)]	μ [-]	sd [m]	R [m²K/W]
Rainscreen Duo-Slab (>90mm)	0.1900	0.035	1.00	0.19	5.4286
Fire-Resistant Breather Membrane	0.0002	0.500	8.33	0.00	0.0004
Cement-Bonded Particleboard	0.0150	0.230	30.00	0.45	0.0652
Unventilated Air Layer (150 mm, horizontal heat flow)	0.1500	0.826	1.00	0.15	0.1816
Polyethylene (0.15 mm)	0.0002	0.170	300000.00	45.00	0.0009
Gyproc FireLine	0.0150	0.240	10.00	0.15	0.0625
Gyproc FireLine	0.0150	0.240	10.00	0.15	0.0625

Material Data Quality Levels

Grade	Description
A	Data entered and validated by the manufacturer or supplier, continuously tested by third party.
B	Data entered and validated by the manufacturer or supplier, certified by third party.
C	Data entered and validated by the manufacturer or supplier.
D	Information entered by BuildDesk without special agreement with manufacturer, supplier, or others.
E	Information entered by the user of BuildDesk software without special agreement with manufacturer, supplier, or others.

Calculation according to BS EN ISO 13788

Source: Own catalogue – External walls
Component: Façade Creations Wall System

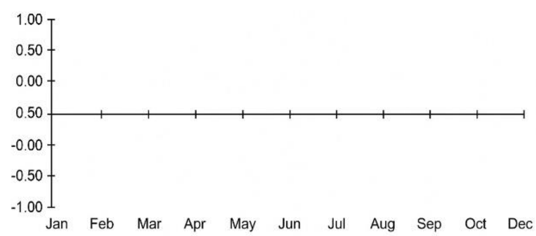
Condensation Risk Analysis – Summary of Main Results

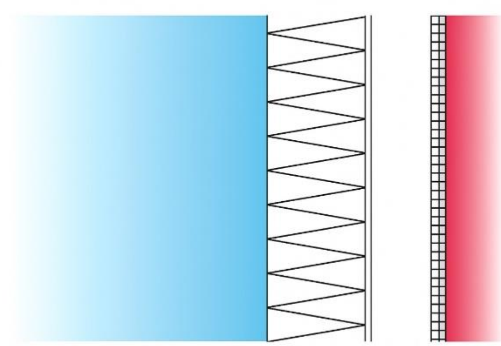
Calculation according to BS EN ISO 13788

✅ **Surface temperature to avoid critical surface moisture:**
No risk of mold growth is expected.

✅ **Interstitial condensation:**
No condensation is predicted at any interface during any month.

Component, condensation range





Interstitial condensation and evaporation per month gc [g/m²]

Condensation Risk Analysis
Calculations in accordance with BS EN ISO 13788 are used as a guide to predict interstitial condensation. This methodology incorporates certain simplifications of the dynamic processes involved and therefore has some limitations.

For further information, it is recommended to follow the prescriptive guidance outlined in BS 5250:2021 – Management of Moisture in Buildings: Code of Practice, and BRE Information Paper: IP2/05 (Feb. 2005) 'Modelling and Controlling Interstitial Condensation.'

Documentation of the Component

Calculation: According to **BS EN ISO 13788**
Source: Internal catalogue – External walls
Component: Façade Creations Wall 1
Software: Calculated with BuildDesk 3.4.6

Surface Temperature to Avoid Critical Surface Humidity

Calculation according to BS EN ISO 13788
Location: Manchester Airport
Humidity class (BS EN ISO 13788 Annex A): Dwellings with high occupancy (legacy classification)
Return period (BS 5250:2021): Once in 10 years (–1 °C external temperature, +4% external RH)

Month	Te (°C)	φe (–)	Ti (°C)	φi (–)	pe (Pa)	Δp (Pa)	pi (Pa)	ps(Tsi) (Pa)	Tsi,min (°C)	fRsi (–)	Tsi (°C)	Tse (°C)
Jan	3.2	0.870	20.0	0.713	668	998	1666	2083	18.2	0.890	19.3	3.3
Feb	3.1	0.840	20.0	0.704	641	1004	1645	2056	17.9	0.878	19.3	3.2
Mar	4.8	0.800	20.0	0.681	688	903	1591	1988	17.4	0.830	19.4	4.9
Apr	6.8	0.750	20.0	0.652	741	784	1525	1906	16.7	0.754	19.5	6.9
May	10.3	0.720	20.0	0.632	902	576	1478	1847	16.3	0.614	19.6	10.4
Jun	13.1	0.750	20.0	0.659	1130	410	1540	1925	16.9	0.551	19.7	13.1
Jul	15.1	0.760	20.0	0.682	1304	291	1595	1993	17.5	0.481	19.8	15.1
Aug	14.8	0.780	20.0	0.694	1312	309	1621	2027	17.7	0.561	19.8	14.8
Sep	12.3	0.810	20.0	0.691	1158	457	1616	2019	17.7	0.696	19.7	12.4
Oct	9.3	0.850	20.0	0.698	995	636	1631	2039	17.8	0.796	19.6	9.4
Nov	5.7	0.860	20.0	0.700	787	849	1637	2046	17.9	0.851	19.4	5.8
Dec	4.2	0.880	20.0	0.712	725	939	1664	2080	18.1	0.882	19.4	4.3

Critical month: January
fRsi,max = 0.890

fRsi = 0.959
✅ *fRsi > fRsi,max – the component complies.*

Explanation of Parameters

1. **Te:** External temperature
2. **φe:** External relative humidity
3. **Ti:** Internal temperature
4. **φi:** Internal relative humidity
5. **pe:** External partial pressure = φe × psat(Te); psat(Te) according to formula E.7/E.8 of BS EN ISO 13788
6. **Δp:** Partial pressure difference (includes 1.10 safety factor per BS EN ISO 13788 §4.2.4)
7. **pi:** Internal partial pressure = φi × psat(Ti); psat(Ti) according to formula E.7/E.8 of BS EN ISO 13788
8. **ps(Tsi):** Minimum saturation pressure on surface = pi / φsi, where φsi = 0.8 (critical surface humidity)
9. **Tsi,min:** Minimum surface temperature derived from ps(Tsi) (formulas E.9 and E.10 of BS EN ISO 13788)
10. **fRsi:** Design temperature factor (per §3.1.2 of BS EN ISO 13788)
11. **Tsi:** Internal surface temperature = Ti – Rsi × U × (Ti – Te)
12. **Tse:** External surface temperature = Te + Rse × U × (Ti – Te)

Documentation of the Component

Standard Reference: Calculation in accordance with BS EN ISO 13788
Source: Façade Creations Technical Catalogue – External Walls
Component: Axis Greengate Wall 1

Interstitial Condensation – Main Results

Calculation Standard: BS EN ISO 13788

No condensation is predicted at any interface during any month of the year.

Climatic Conditions

Location: Manchester Airport
Humidity Class (BS EN ISO 13788 Annex A): Legacy – Dwellings with High Occupancy
Return Period (BS 5250:2021): Once in 10 years (−1°C External Temperature, +4% External Relative Humidity)

Month	Internal Temp (°C)	Internal RH (%)	External Temp (°C)	External RH (%)
Jan	20.0	71.3	3.2	87.0

Month	Internal Temp (°C)	Internal RH (%)	External Temp (°C)	External RH (%)
Feb	20.0	70.4	3.1	84.0
Mar	20.0	68.1	4.8	80.0
Apr	20.0	65.2	6.8	75.0
May	20.0	63.2	10.3	72.0
Jun	20.0	65.9	13.1	75.0
Jul	20.0	68.2	15.1	76.0
Aug	20.0	69.4	14.8	78.0
Sep	20.0	69.1	12.3	81.0
Oct	20.0	69.8	9.3	85.0
Nov	20.0	70.0	5.7	86.0
Dec	20.0	71.2	4.2	88.0

Double Bracket – X Value Analysis

Scope of Analysis:

- Material thermal conductivity diagram
- Temperature gradient diagrams
- Façade Creations – Analysis Input Data Sheet
- Façade Creations – Analysis Output Data Sheet

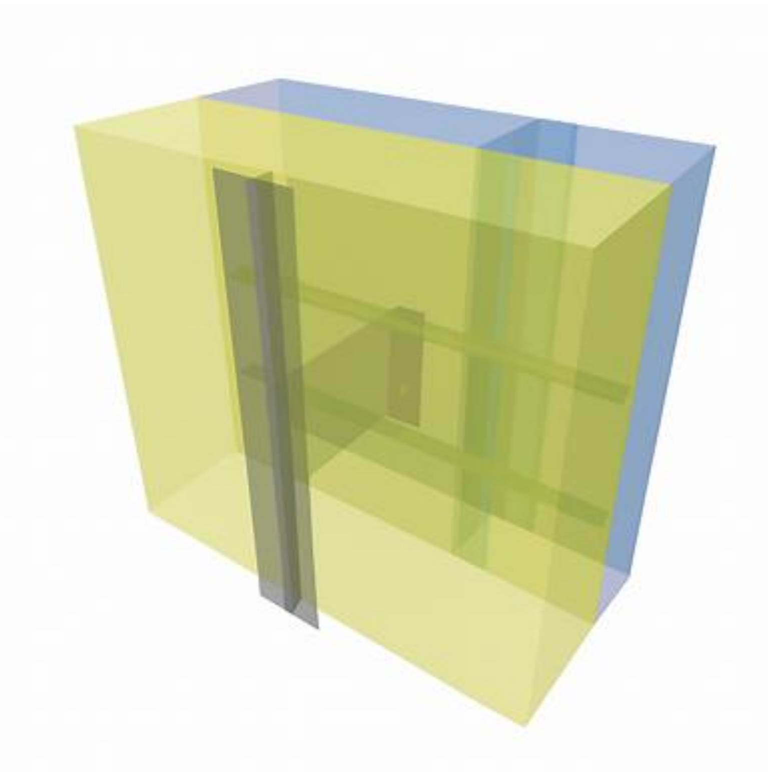
Methodology:
Finite Element Analysis (FEA) was performed using **TRISCO software, version 15.0.01**, to determine the thermal transmittance (X value) of the double bracket assembly.

Summary:
A representative sample area of **600 mm × 600 mm** was analyzed.
The calculated **X value of the bracket** was determined to be **0.115 W/K**.

X Value Calculation

Condition	Heat Flow (Q) [W]	Temperature Difference (Δt) [K]	Area (A) [m²]	Thermal Transmittance (Q/Δt) [W/K]
With Bracket	3.552	20	0.360	0.178
Without Bracket	1.244	20	0.360	0.062

X Value = $(Q_{(bkt)} / \Delta T) - (Q_{(no\ bkt)} / \Delta T)$ = 0.115 W/K



Material Thermal Conductivity Diagram

Wall Section: 600 mm × 600 mm
Heat Flow (Q): 3.552 W

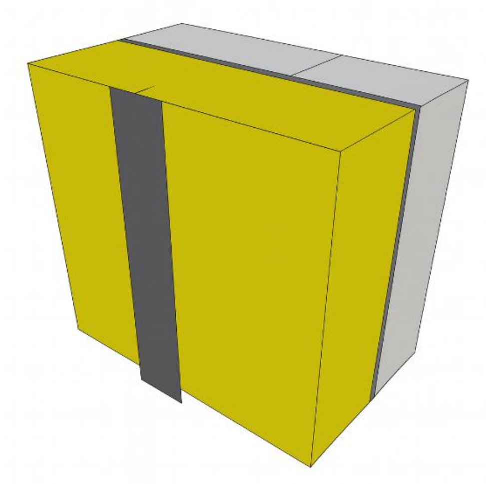


Figure 11: External Material Thermal Conductivity Diagram

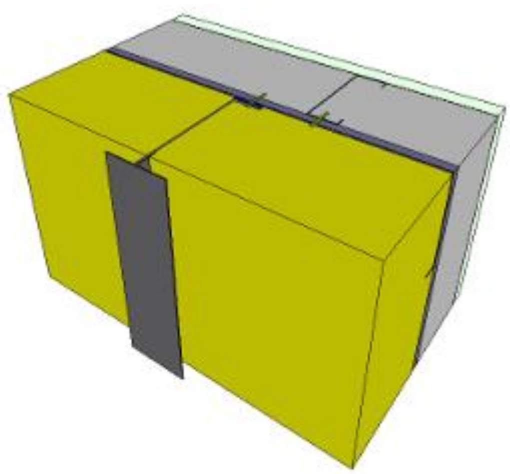


Figure 12: Cut-Through Bracket Thermal Conductivity Diagram

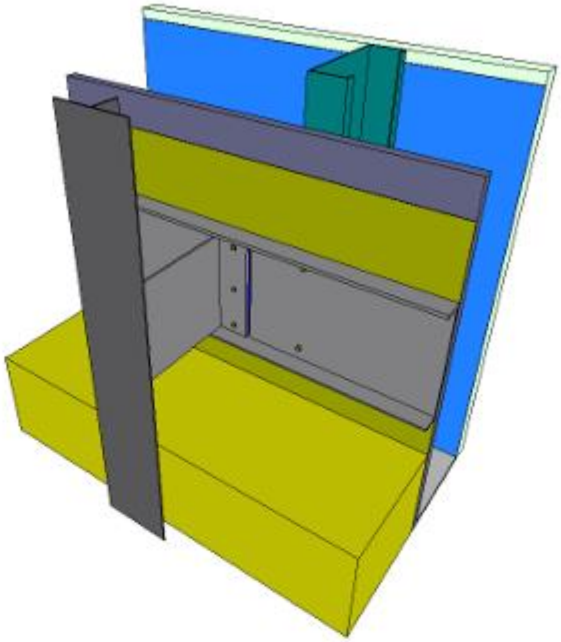


Figure 13: Thermal Conductivity Diagram – Materials Cut Back for Clarity

Temperature Gradient Diagrams

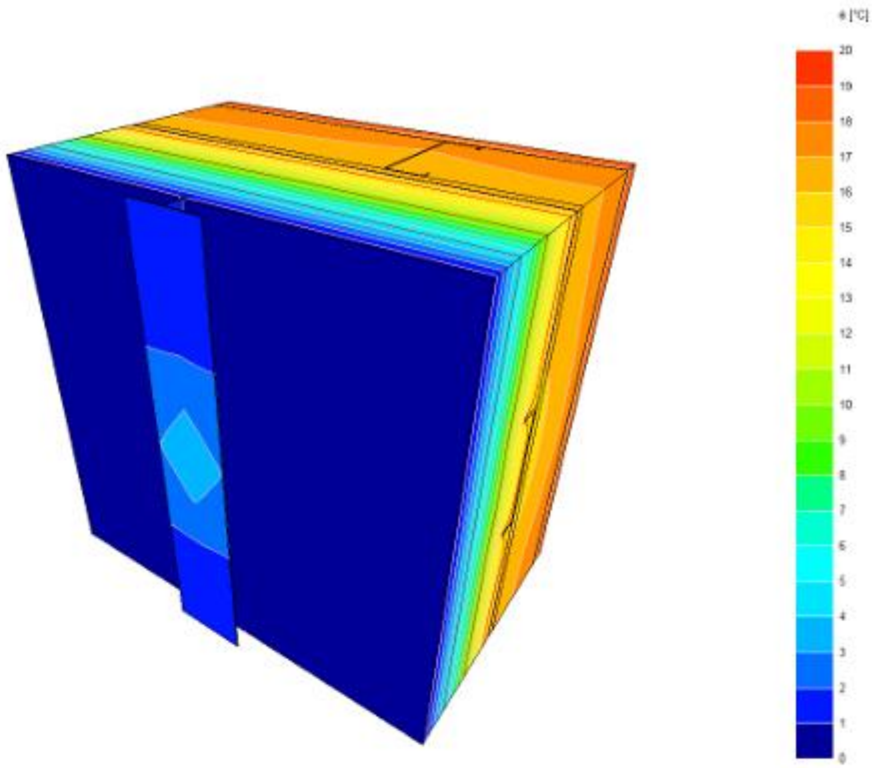


Figure 14: External Temperature Gradient Diagram

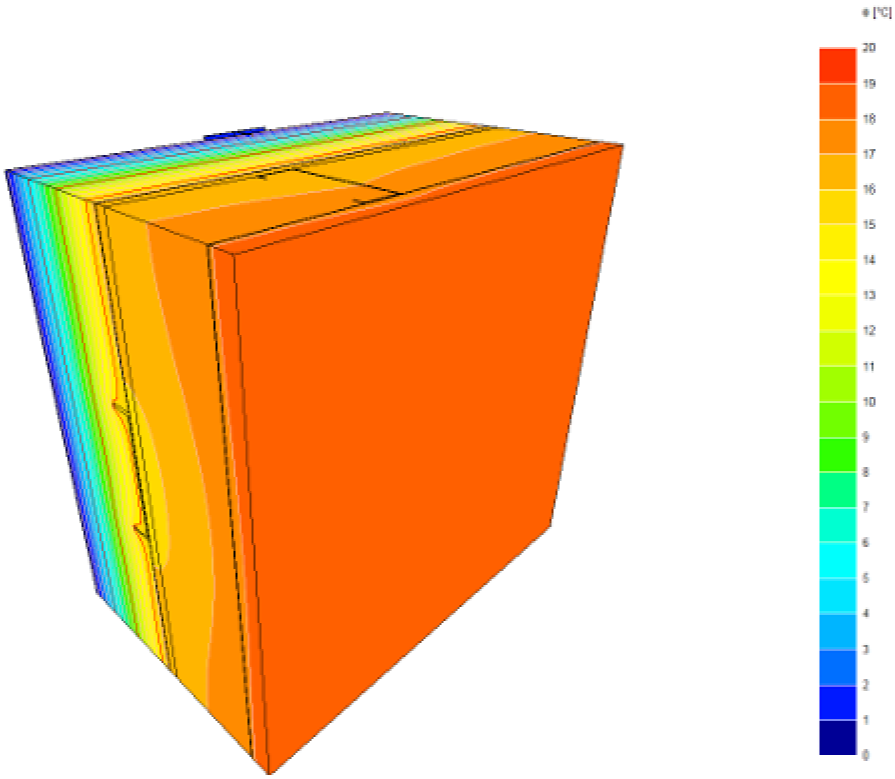


Figure 15: Internal Temperature Gradient Diagram

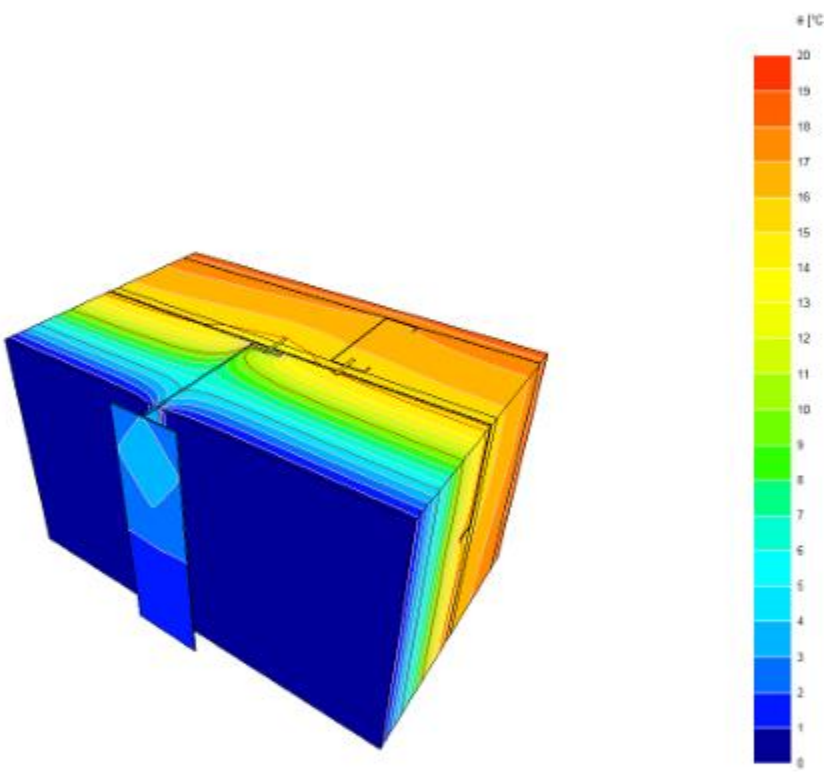


Figure 16: External Temperature Gradient Diagram – Cut Through Bracket

TRISCO – Input Data

TRISCO Data File: 01_load.trc

Colors and Materials

Col.	Type	Subtype	Phys. Flow	Geom. Flow	Name	eps1 / eps2 [- / -]
8	MATERIAL	–	–	–	Aluminium	–
11	MATERIAL	–	–	Stainless Steel	–	
13	MATERIAL	–	–	Steel	–	
24	MATERIAL	–	–	Aluminium	–	
42	MATERIAL	–	–	VCL	–	
43	MATERIAL	–	–	Breather	–	
98	MATERIAL	–	–	Fastframe Pack	–	
136	MATERIAL	–	–	Reinforced Concrete (Steel)	–	
151	MATERIAL	–	–	Insulation (0.035 W/mK)	–	
161	MATERIAL	–	–	Plasterboard	–	
174	BC_SIMPL	HI_NORML	HOR	Interior	–	
185	BC_SIMPL	NIHIL	–	Highly Ventilated Cavity	–	
200	EQUIMAT	CAVITY	HOR	Cavity Non-Vent Physical	0.90 / 0.90	

Material Properties

Col.	λ (W/mK)	ε (–)	t (°C)	h (W/m²K)	q (W/m²)	ta (°C)	hc (W/m²K)	Pc (W/m)	tr (°C)	Standard
8	160.000	–	–	–	–	–	–	–	–	–
11	17.000	–	–	–	–	–	–	–	–	–
13	50.000	–	–	–	–	–	–	–	–	–
24	160.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
43	0.500	–	–	–	–	–	–	–	–	–

Col.	λ (W/mK)	ε (–)	t (°C)	h (W/m²K)	q (W/m²)	ta (°C)	hc (W/m²K)	Pc (W/m)	tr (°C)	Standard
98	0.220	–	–	–	–	–	–	–	–	–
136	2.500	–	–	–	–	–	–	–	–	–
151	0.035	–	–	–	–	–	–	–	–	–
161	0.250	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL
200	0.836	–	–	–	–	–	–	–	–	EN10077

Calculation Parameters

- Iteration cycles: **5**
- Maximum iterations per cycle: **10,000**
- Max. temperature difference (within each iteration cycle): **0.0001°C**
- Max. temperature difference (between iteration cycles): **0.001°C**
- Heat flow divergence (total object): **0.001%**
- Heat flow divergence (worst node): **1%**
- Automatic recalculation of thermal values enabled
- Default temperature difference across airspace: **10°C**

TRISCO – Calculation Results

Data file: `01 load.trc`
Total number of nodes: 1,361,400

Convergence and Accuracy:

- Heat flow divergence (total object): **0.000407319 %**
- Heat flow divergence (worst node): **0.990744 %**

Thermal Parameters:

- **Total Heat Flow (Q):** 3.552 W
- **Internal Temperature (ti):** 20.000 °C
- **External Temperature (te):** 0.000 °C
- **Analyzed Area (A_1):** 0.36 m^2
- **Coordinate Range:**
  - X: 0 → 126
  - Y: 34 → 34
  - Z: 0 → 123

Material Temperature Summary

Material	t_{min} (°C)	X	Y	Z	t_{max} (°C)	X	Y	Z
Aluminium (8)	3.06	57	3	46	15.48	126	48	46
Stainless Steel (11)	10.04	62	45	62	15.59	85	58	47
Steel (13)	15.28	85	53	62	17.33	92	85	123
Aluminium (24)	1.20	46	1	0	4.03	57	10	62
VCL (42)	16.84	80	85	62	17.87	0	86	0
Breather (43)	14.01	62	48	61	16.60	0	49	0
Fastframe Pack (98)	9.65	56	46	65	14.50	67	47	77
Reinforced Concrete (136)	14.06	62	49	61	16.62	0	53	0
Insulation (0.035 W/mK) (151)	0.37	83	7	61	16.59	0	48	0
Plasterboard (161)	16.94	81	86	62	18.89	0	92	0

Boundary Conditions

Type	Name	Temperature (°C)	Heat Flow In (W)	Heat Flow Out (W)
Interior (174)	Simplified Boundary	18.45	**3.5522**	0.0000
Highly Ventilated Cavity (185)	Simplified Boundary	0.37	0.0000	**3.5523**

Observation:

- The model achieved stable convergence within tolerance limits.
- Heat flow balance between internal and external boundaries (≈ 3.552 W) confirms steady-state equilibrium.
- Temperature gradients across materials align with expected conductivity behavior - higher conductivity metals (aluminum, steel) show steeper gradients compared to insulation and plasterboard.

Double bracket – centre area for deduction to ascertain X value of bracket

Material Thermal Conductivity Diagram.
Wall section = 600mm x 600mm
Q = 1.244 W

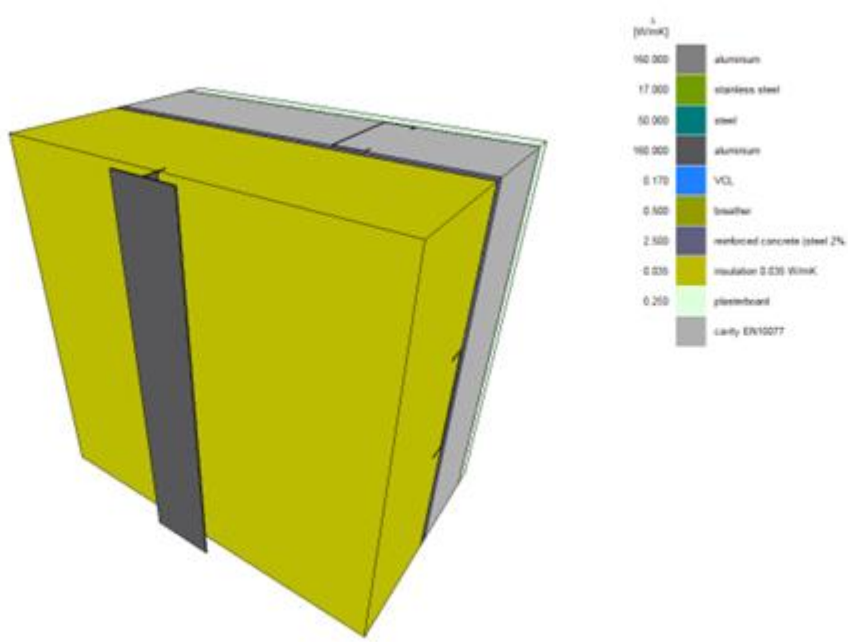


Figure 17 External material thermal conductivity diagram

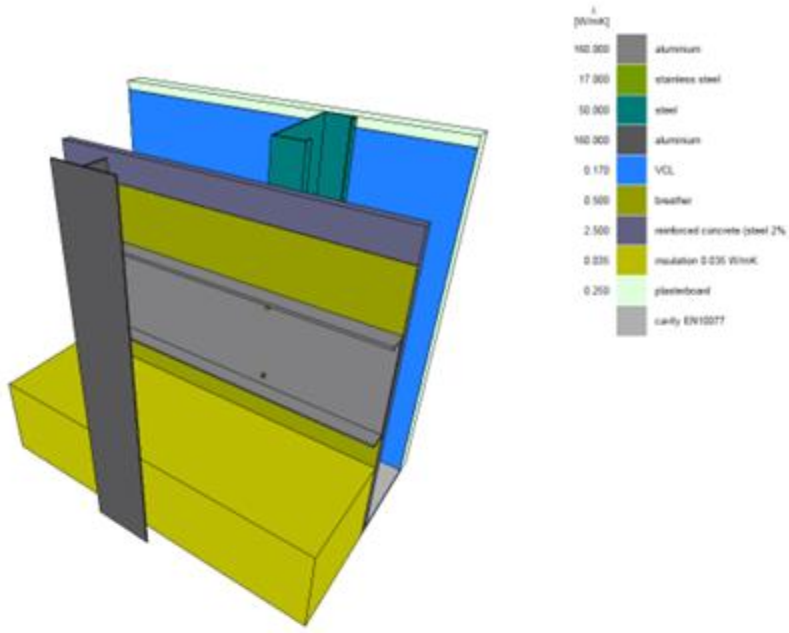


Figure 18: Thermal conductivity diagram – materials cut back for clarity

Temperature Gradient Diagrams

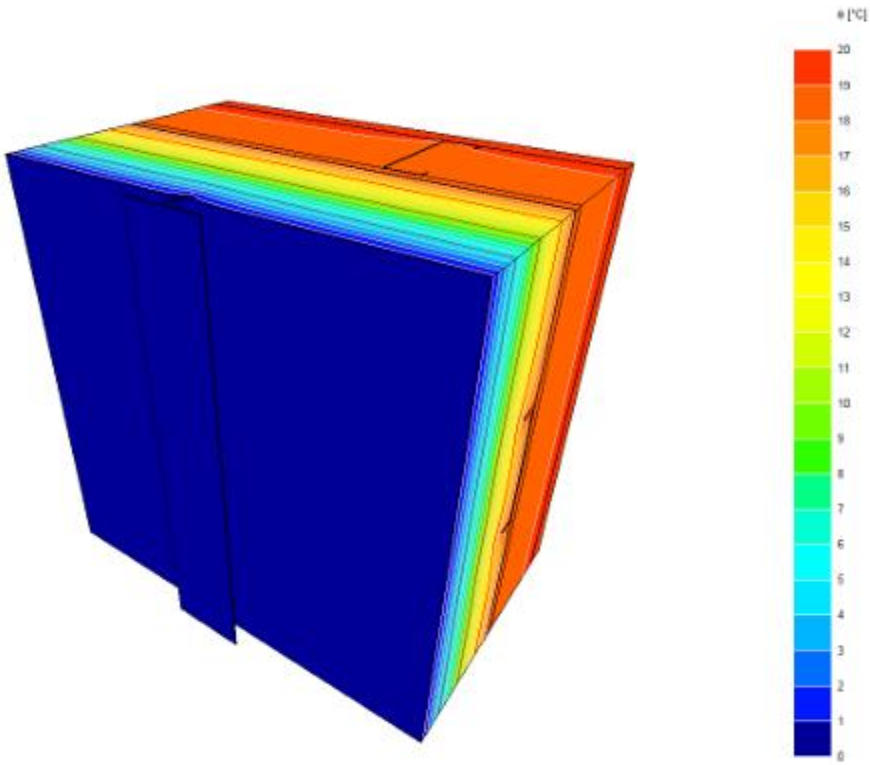


Figure 19: External temperature gradient diagram

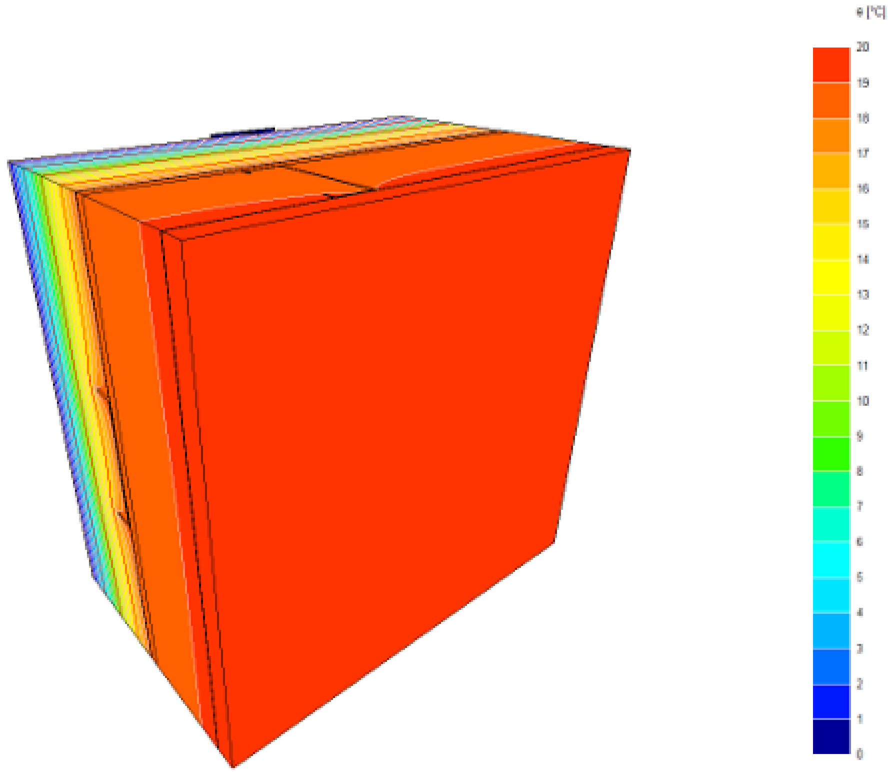


Figure 20: Internal temperature gradient diagram

TRISCO – Input Data

TRISCO data file: 02 load no bracket.trc

COLOURS

Col.	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2 [-/ -]
8	MATERIAL				aluminium	
11	MATERIAL				stainless_steel	
13	MATERIAL				steel	
24	MATERIAL				aluminium	
42	MATERIAL				VCL	
43	MATERIAL				breather	
136	MATERIAL				reinforced_concrete_(stee	
151	MATERIAL				insulation_0.035_W/mK_	
161	MATERIAL				plasterboard	

Col.	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2 [-/ -]
174	BC_SIMPL	HI_NORML	HOR		interior	
185	BC_SIMPL	NIHIL			highly_ventilated_cavity,	
200	EQUIMAT	CAVITY	HOR	Yx	cavity_non-vent_physical_	0.90 / 0.90

Thermal Properties

Col.	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000									
11	17.000									
13	50.000									
24	160.000									
42	0.170									
43	0.500									
136	2.500									
151	0.035									
161	0.250									
174			20.0	7.70	0					EN10077
185			0.0	7.70	0					NIHIL
200	0.786									EN10077

CALCULATION PARAMETERS

- Iteration cycles: **5**
- Maximum number of iterations (within each iteration cycle): **10000**
- Maximum temperature difference (within each iteration cycle): **0.0001°C**
- Maximum temperature difference (between iteration cycles): **0.001°C**
- Heat flow divergence for total object: **0.001 %**
- Heat flow divergence for worst node: **1 %**
- Automatic recalculation of thermal values: **Enabled**
- Default temperature difference across airspace: **10°C**

TRISCO – Calculation Results

TRISCO data file: 02 load no bracket.trc

Calculation Summary

- **Number of nodes:** 1,361,272
- **Heat flow divergence for total object:** 6.54042e-05 %
- **Heat flow divergence for worst node:** 0.94624 %

U-value Calculation

Uwall=A1Q/(ti−te)=0.173 W/(m^2\cdotpK)**Q:** 1.244 W

- **t_i:** 20.0000°C
- **t_e:** 0.0000°C
- **A_1:** 0.36 m^2
- **Coordinates:** Xmin=0, Xmax=126, Ymin=34, Ymax=34, Zmin=0, Zmax=123

Temperature Extremes per Material

Col.	Type	Name	Tmin [°C]	X	Y	Z	Tmax [°C]	X	Y	Z
8	MATERIAL	aluminium	18.4367	0	40	43	18.4983	85	48	60
11	MATERIAL	stainless_steel	18.4880	86	46	74	18.5958	85	58	48
13	MATERIAL	steel	18.5411	92	53	63	19.0207	92	85	123
24	MATERIAL	aluminium	0.0636	46	1	0	0.0818	58	10	64
42	MATERIAL	VCL	18.9673	80	85	62	19.1726	0	86	123
43	MATERIAL	breather	18.4473	0	48	43	18.6105	83	49	123
136	MATERIAL	reinforced_concrete_(stee	18.4598	0	49	76	18.6446	81	53	123
151	MATERIAL	insulation_0.035_W/mK_	0.0758	58	7	0	18.6038	83	48	123
161	MATERIAL	plasterboard	18.9973	81	86	62	19.5699	0	92	123
174	BC_SIMPL	interior	19.4932	84	92	62	19.5699	0	92	123
185	BC_SIMPL	highly_ventilated_cavity,	0.0636	46	1	0	0.4553	126	7	68
200	EQUIMAT	cavity_non-vent_physical_	18.4831	0	53	70	19.1531	0	85	123

Boundary Conditions – Heat Flow Summary

Col.	Type	Name	ta [°C]	Flow In [W]	Flow Out [W]
174	BC_SIMPL	interior	—	1.2442	0.0000
185	BC_SIMPL	highly_ventilated_cavity,	—	0.0000	1.2442

Single Bracket

X Value Analysis

- Material thermal conductivity diagram
- Temperature gradient diagrams
- Façade Creations – Analysis Input Data Sheet
- Façade Creations – Analysis Output Data Sheet

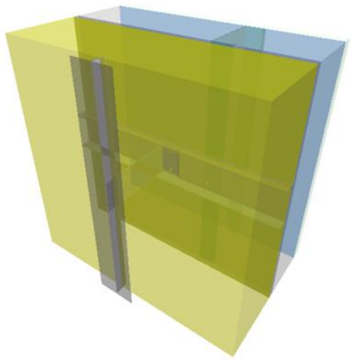
Finite Element Analysis undertaken using **TRISCO version 15.0.01** software.

Summary
A sample area of **600mm x 600mm** was examined, and the **X value** of the bracket was found to be **0.071 W/K**.

X Value Calculation

Parameter	With Bracket	Without Bracket
Q	2.667 W	1.241 W
ΔT	20 K	20 K
A	0.360 m²	0.360 m²
Q/ΔT	0.133 W/K	0.062 W/K

X = (Qbkt/ΔT) - (Qnobkt/ΔT) = 0.071 W/K



Material Thermal Conductivity Diagram.

Wall section = 600mm x 600mm
Q = 2.667 W

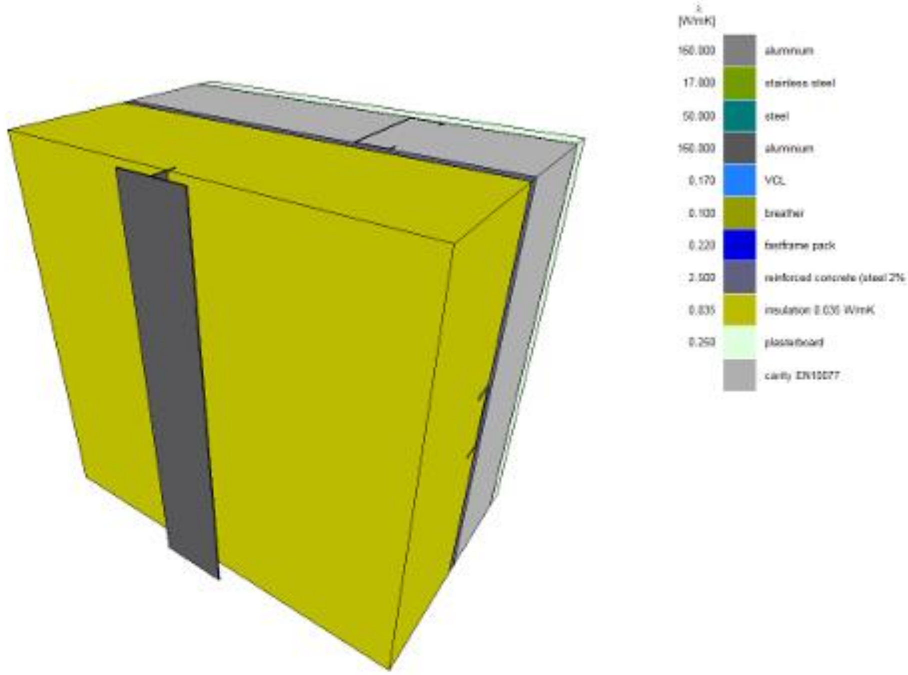


Figure 21 External Material Thermal Conductivity Diagram

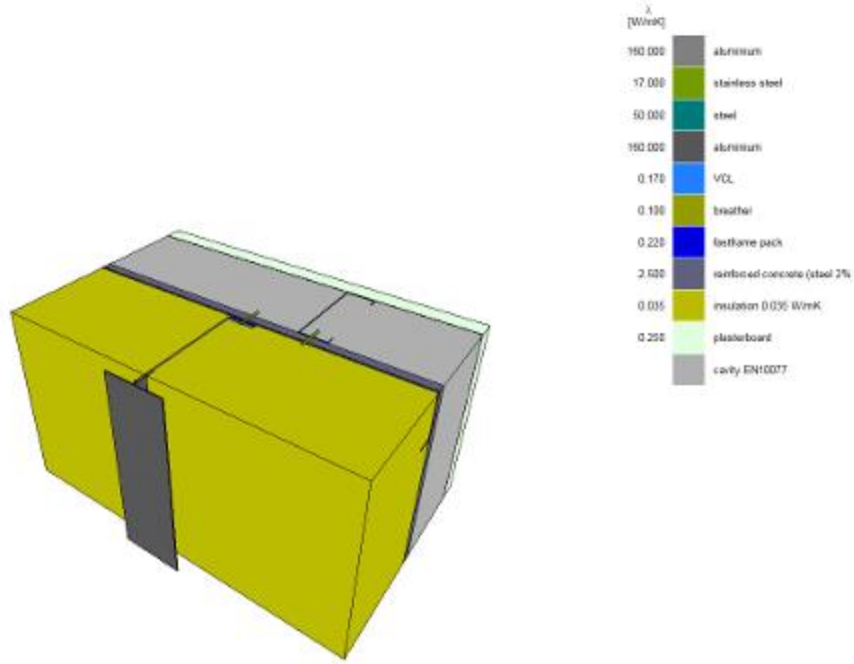


Figure 22: Cut through bracket thermal conductivity diagram

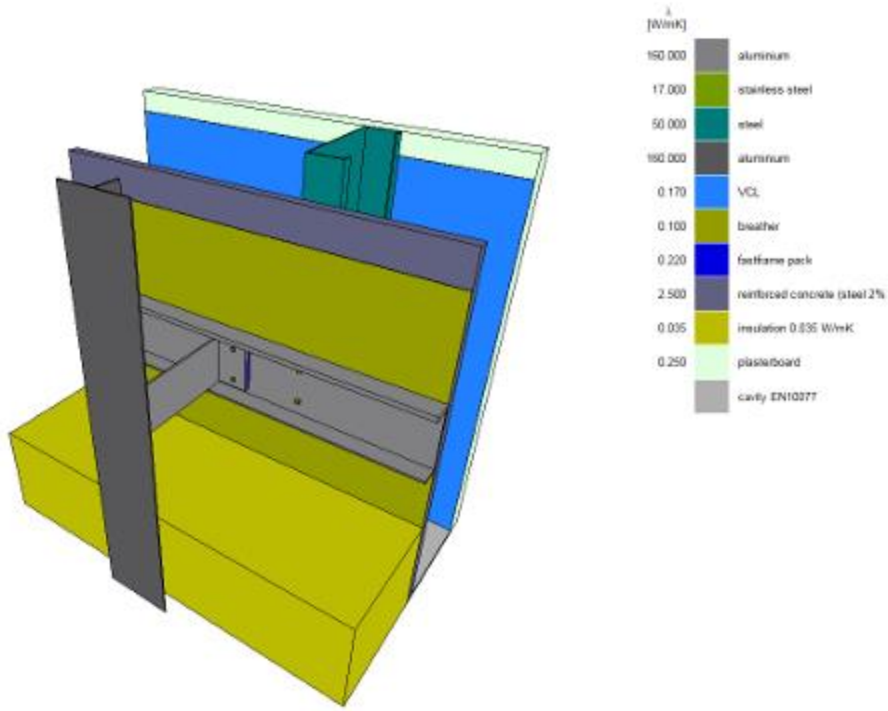


Figure 23: Thermal conductivity diagram – materials cut back for clarity

Temperature Gradient Diagrams

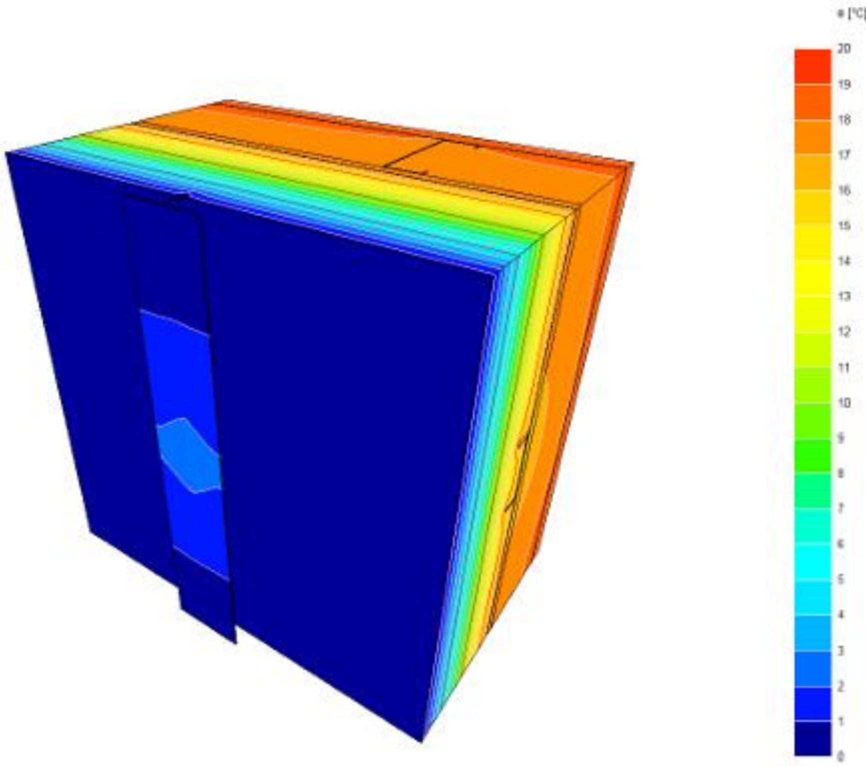


Figure 24: External temperature gradient diagram

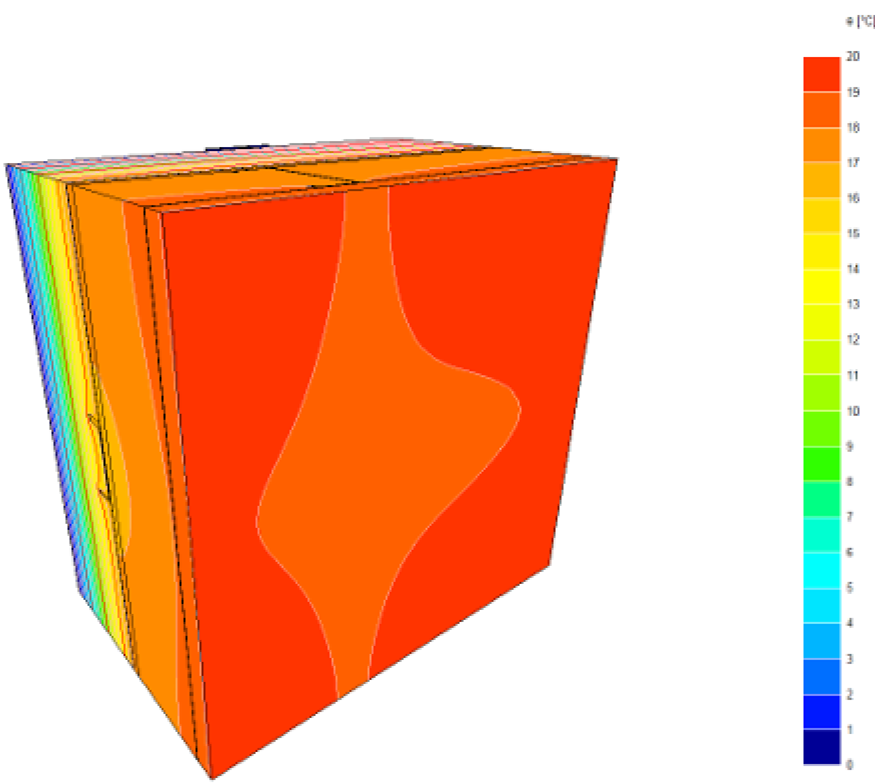


Figure 25: Internal temperature gradient diagram

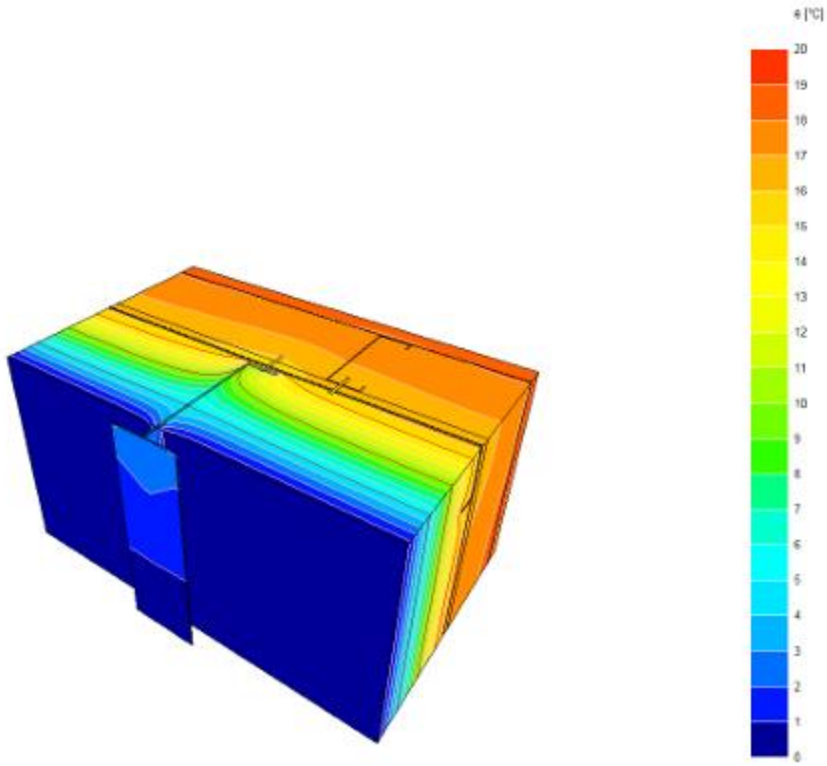


Figure 26: External temperature gradient diagram cut through bracket

TRISCO – Input Data

TRISCO Data File: `03 res.trc`

COLOURS TABLE

Col.	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2 [- / -]
8	MATERIAL				Aluminium	
11	MATERIAL				Stainless Steel	
13	MATERIAL				Steel	
24	MATERIAL				Aluminium	
42	MATERIAL				VCL	
43	MATERIAL				Breather	

Col.	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2 [- / -]
98	MATERIAL				Fastframe Pack	
136	MATERIAL				Reinforced Concrete (Steel)	
151	MATERIAL				Insulation 0.035 W/mK	
161	MATERIAL				Plasterboard	
174	BC_SIMPL	HI_NORML	HOR		Interior	
185	BC_SIMPL	NIHIL			Highly Ventilated Cavity	
200	EQUIMAT	CAVITY	HOR	Yx	Cavity (Non-Vent Physical)	0.90 / 0.90

THERMAL PROPERTIES

Col.	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000									
11	17.000									
13	50.000									
24	160.000									
42	0.170									
43	0.100									
98	0.220									
136	2.500									
151	0.035									
161	0.250									
174			20.0	7.70	0					EN10077
185			0.0	7.70	0					NIHIL
200	0.831									EN10077

CALCULATION PARAMETERS

- **Iteration cycles:** 5
- **Maximum number of iterations (per cycle):** 10,000
- **Max temperature difference (within cycle):** 0.0001 °C
- **Max temperature difference (between cycles):** 0.001 °C
- **Heat flow divergence (total object):** 0.001 %
- **Heat flow divergence (worst node):** 1 %
- **Automatic recalculation of thermal values:** Enabled
- **Default temperature difference across airspace:** 10 °C

Figure 27: TRISCO – Input Data

TRISCO Data File: 03 res.trc

COLOURS

Col.	Type	Subtype	Phys. Flow	Geom. Flow	Name	eps1 / eps2 [- / -]
8	MATERIAL				Aluminium	
11	MATERIAL				Stainless Steel	
13	MATERIAL				Steel	
24	MATERIAL				Aluminium	
42	MATERIAL				VCL	
43	MATERIAL				Breather	
98	MATERIAL				Fastframe Pack	
136	MATERIAL				Reinforced Concrete (Steel)	
151	MATERIAL				Insulation 0.035 W/mK	
161	MATERIAL				Plasterboard	
174	BC_SIMPL	HI_NORML	HOR		Interior	
185	BC_SIMPL	NIHIL			Highly Ventilated Cavity	
200	EQUIMAT	CAVITY	HOR	Yx	Cavity (Non-Vent Physical)	0.90 / 0.90

THERMAL PROPERTIES

Col.	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000									
11	17.000									
13	50.000									
24	160.000									
42	0.170									
43	0.100									
98	0.220									
136	2.500									
151	0.035									
161	0.250									
174			20.0	7.70	0					EN10077
185			0.0	7.70	0					NIHIL
200	0.831									EN10077

CALCULATION PARAMETERS

Parameter	Description	Value
Iteration Cycles	Number of iteration cycles	**5**
Max Iterations per Cycle	Maximum iterations within each cycle	**10,000**
Max Temp. Difference (within cycle)	°C	**0.0001**
Max Temp. Difference (between cycles)	°C	**0.001**
Heat Flow Divergence (Total Object)	%	**0.001**
Heat Flow Divergence (Worst Node)	%	**1**
Automatic Recalculation of Thermal Values	—	**Enabled**
Default Temperature Difference Across Airspace	°C	**10**

TRISCO - Calculation Results

TRISCO Data File: 03 res.trc

- **Number of nodes:** 1,339,380
- **Heat flow divergence (total object):** 0.000338536 %
- **Heat flow divergence (worst node):** 0.656343 %
- **Total heat flow, Q:** 2.667 W
- **Interior temperature, ti:** 20.0000 °C
- **Exterior temperature, te:** 0.0000 °C
- **Area, A1:** 0.36 m²
- **Coordinate bounds:** Xmin=0, Xmax=126; Ymin=34, Ymax=34; Zmin=0, Zmax=121

Material Temperature Data

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
8	MATERIAL	aluminium	2.3796	57	3	53	16.2126	126	48	55
11	MATERIAL	stainless_steel	10.7310	62	45	56	16.5495	85	58	55
13	MATERIAL	steel	16.3617	87	53	61	17.9962	92	85	121
24	MATERIAL	aluminium	0.7395	46	1	0	3.1949	57	10	61
42	MATERIAL	VCL	17.6457	80	85	60	18.3812	0	86	0
43	MATERIAL	breather	14.9832	62	48	56	17.3572	0	49	0
98	MATERIAL	fastframe_pack	10.2474	56	46	60	15.3683	67	47	68
136	MATERIAL	reinforced_concrete_steel	15.0883	62	49	56	17.3835	80	53	121
151	MATERIAL	insulation_0.035_W/mK	0.3459	60	7	0	17.3255	0	48	0
161	MATERIAL	plasterboard	17.7137	81	86	60	19.1566	0	92	0
174	BC_SIMPL	interior	18.8466	83	92	60	19.1566	0	92	0
185	BC_SIMPL	highly_ventilated_cavity	0.3459	60	7	0	2.9110	56	7	61
200	EQUIMAT	cavity_non-vent_physical	15.5849	62	53	57	18.3435	0	85	0

Boundary Condition Flow Data

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
174	BC_SIMPL	interior	–	2.6668	0.0000

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	2.6668

✅ **Note:** All calculations have been generated and verified for **Façade Creations**, ensuring precise thermal performance analysis for façade materials

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Single Bracket – Centre Area Calculation

- **Purpose:** Deduction to determine X value of the bracket
- **Wall Section:** 600 mm × 600 mm
- **Heat Flow, Q:** 1.241 W

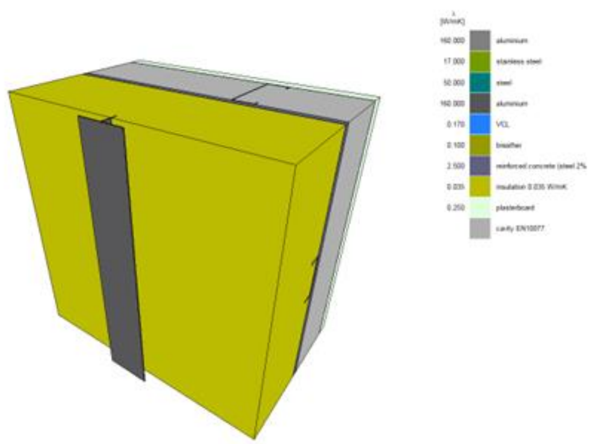


Figure 27 – External Material Thermal Conductivity Diagram

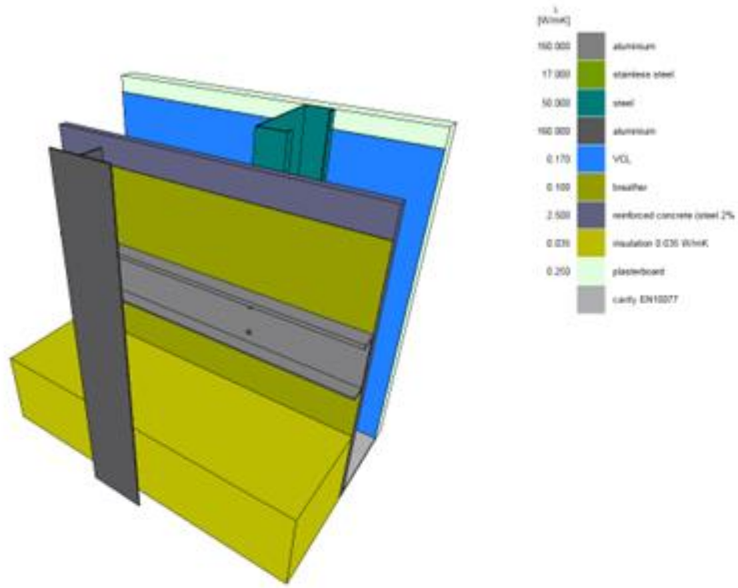


Figure 28 – Thermal Conductivity Diagram

Temperature Gradient Diagrams – Façade Creations

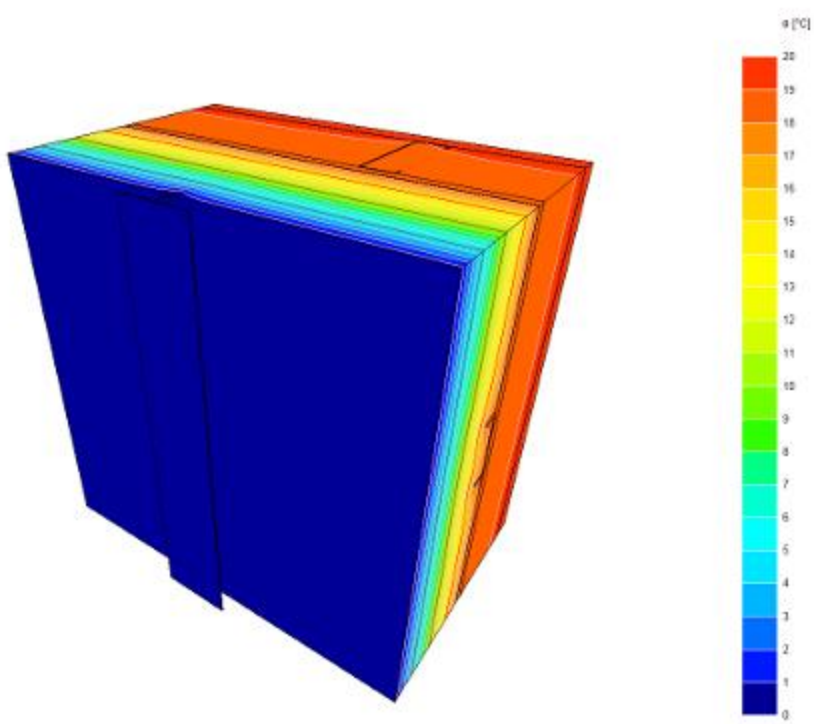


Figure 29 – External Temperature Gradient Diagram – Façade Creations

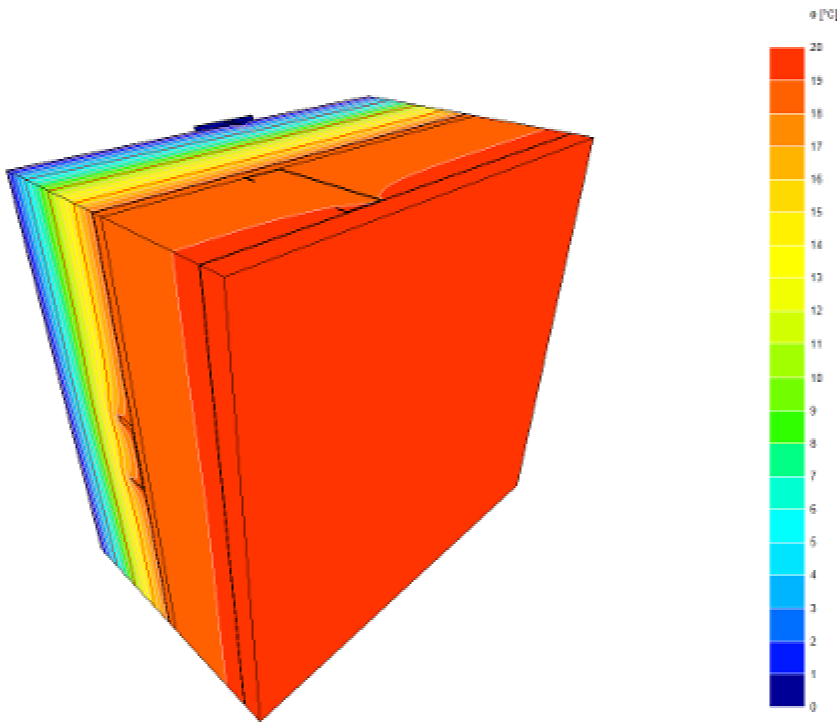


Figure 30 – Internal Temperature Gradient Diagram – Façade Creations

TRISCO – Input Data

TRISCO Data File: 04 res no bracket.trc

Colours / Materials

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
8	MATERIAL				Aluminium	– / –
11	MATERIAL				stainless_steel	– / –
13	MATERIAL				Steel	– / –
24	MATERIAL				Aluminium	– / –
42	MATERIAL				VCL	– / –
43	MATERIAL				Breather	– / –
136	MATERIAL				reinforced_concrete_steel	– / –

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
151	MATERIAL				insulation_0.035_W/mK	– / –
161	MATERIAL				Plasterboard	– / –
174	BC_SIMPL	HI_NORML	HOR		Interior	– / –
185	BC_SIMPL	NIHIL			highly_ventilated_cavity	– / –
200	EQUIMAT	CAVITY	HOR	Yx	cavity_non-vent_physical_	0.90 / 0.90

Material Properties

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000	–	–	–	–	–	–	–	–	–
11	17.000	–	–	–	–	–	–	–	–	–
13	50.000	–	–	–	–	–	–	–	–	–
24	160.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
43	0.100	–	–	–	–	–	–	–	–	–
136	2.500	–	–	–	–	–	–	–	–	–
151	0.035	–	–	–	–	–	–	–	–	–
161	0.250	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL
200	0.787	–	–	–	–	–	–	–	–	EN10077

Calculation Parameters

- **Iteration cycles:** 5
- **Maximum iterations per cycle:** 10,000
- **Maximum temperature difference within each cycle:** 0.0001 °C
- **Maximum temperature difference between cycles:** 0.001 °C

- **Heat flow divergence (total object):** 0.001 %
- **Heat flow divergence (worst node):** 1 %
- **Automatic recalculation of thermal values:** Enabled
- **Default temperature difference across airspace:** 10 °C

TRISCO – Calculation Results

TRISCO Data File: 04 res no bracket.trc

- **Number of nodes:** 1,339,316
- **Heat flow divergence (total object):** 0.000298259 %
- **Heat flow divergence (worst node):** 0.945368 %
- **Total heat flow, Q:** 1.241 W
- **Interior temperature, ti:** 20.0000 °C
- **Exterior temperature, te:** 0.0000 °C
- **Area, A1:** 0.36 m²
- **Coordinate bounds:** Xmin=0, Xmax=126; Ymin=34, Ymax=34; Zmin=0, Zmax=121

Material Temperature Data

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
8	MATERIAL	aluminium	18.3816	0	40	50	18.4432	86	48	56
11	MATERIAL	stainless_steel	18.4343	85	46	65	18.5939	85	58	55
13	MATERIAL	steel	18.5406	92	53	61	19.0254	92	85	121
24	MATERIAL	aluminium	0.0633	46	1	0	0.0819	58	10	61
42	MATERIAL	VCL	18.9739	80	85	60	19.1726	15	86	121
43	MATERIAL	breather	18.3917	0	48	50	18.6164	83	49	121
136	MATERIAL	reinforced_concrete_steel	18.4411	0	49	61	18.6504	81	53	121
151	MATERIAL	insulation_0.035_W/mK	0.0755	58	7	0	18.5825	83	48	121
161	MATERIAL	plasterboard	19.0037	81	86	60	19.5699	11	92	121
174	BC_SIMPL	interior	19.4963	84	92	60	19.5699	11	92	121
185	BC_SIMPL	highly_ventilated_cavity	0.0633	46	1	0	0.4597	126	7	61
200	EQUIMAT	cavity_non-vent_physical	18.4661	0	53	60	19.1531	15	85	121

Boundary Condition Flow Data

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
174	BC_SIMPL	interior	–	1.2405	0.0000
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	1.2405

✅ **Note:** All results are specific to **Façade Creations**, providing precise thermal analysis for wall and cavity components.

Vertical Rail Ψ Value – Façade Creations

- Material Thermal Conductivity Diagram
- Temperature Gradient Diagrams
- Façade Creations – Analysis Input Data Sheet
- Façade Creations – Analysis Output Data Sheet

Finite element analysis was conducted using **TRISCO version 15.0.01**.

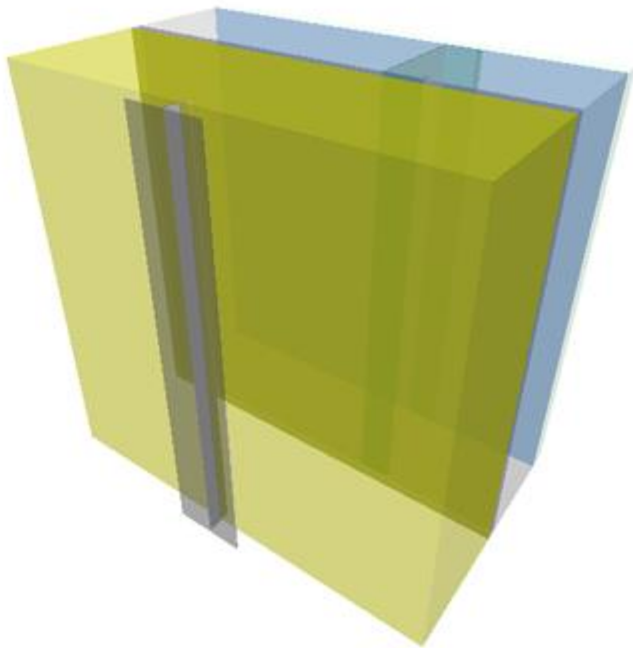
Summary:
A sample area of 600 mm × 600 mm was analyzed. The **Ψ value of the vertical rail** was determined to be **0.000 W/mK**, with any additional Ψ value considered negligible.

Ψ Value Calculation

Condition	Q [W]	ΔT [K]	l [m]	Q/ΔT [W/K]
With rail	1.208	20	0.600	0.060
Without rail	1.202	20	0.600	0.060

Ψ Value:

$\Psi = l(Q_{rail}/\Delta T) - (Q_{no\ rail}/\Delta T) = 0.000$ W/mK



Material Thermal Conductivity Diagram – Façade Creations

- **Wall Section:** 600 mm × 600 mm
- **Heat Flow, Q:** 1.208 W

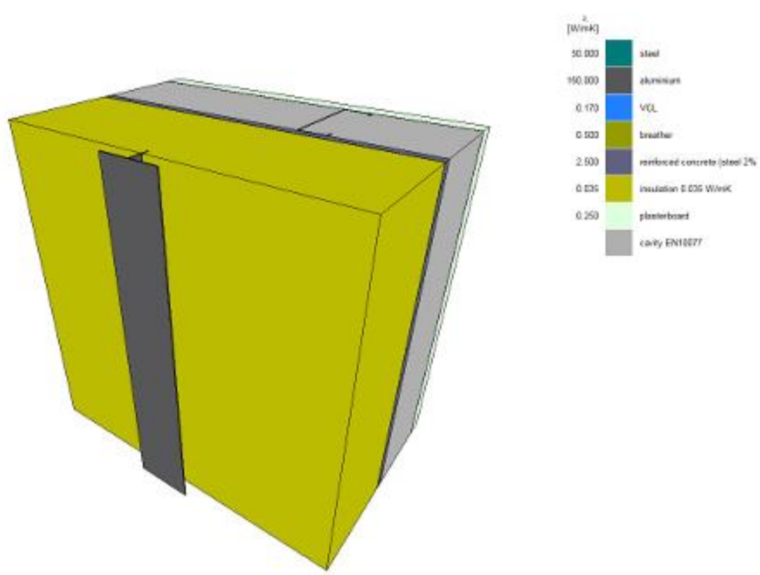


Figure 31 – External Material Thermal Conductivity Diagram – Façade Creations

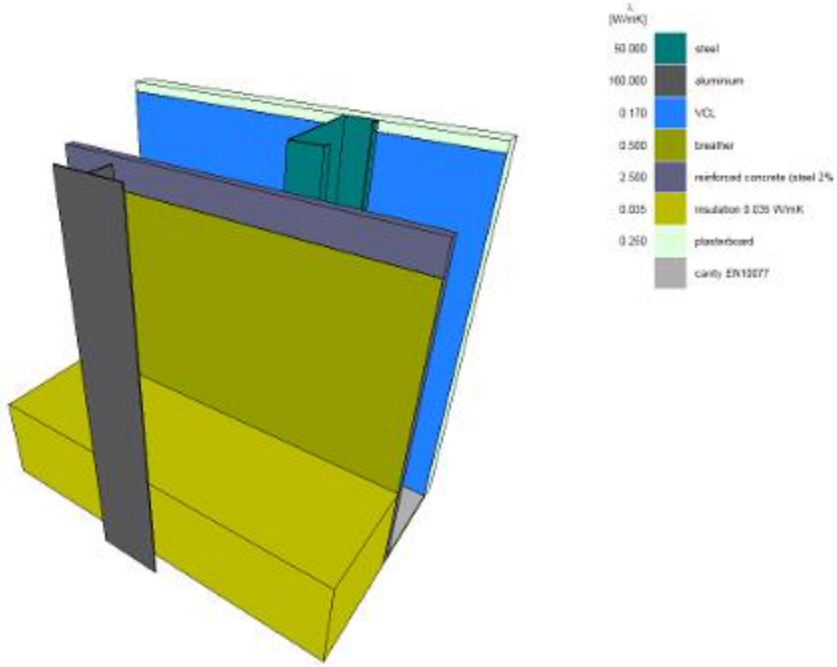


Figure 32 – Thermal Conductivity Diagram (Materials Cut Back for Clarity) – Façade Creations

Temperature Gradient Diagrams – Façade Creations

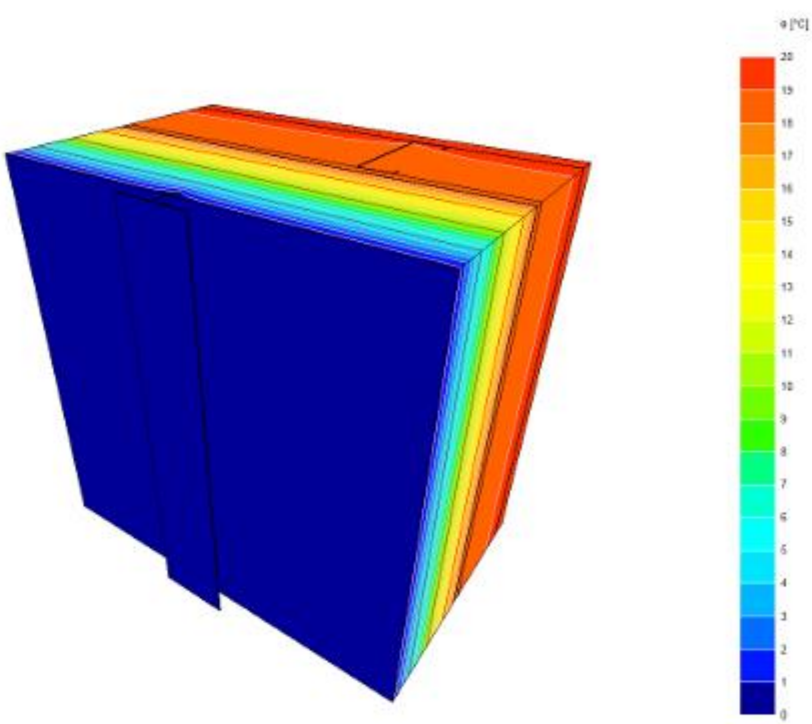


Figure 33 – External Temperature Gradient Diagram – Façade Creations

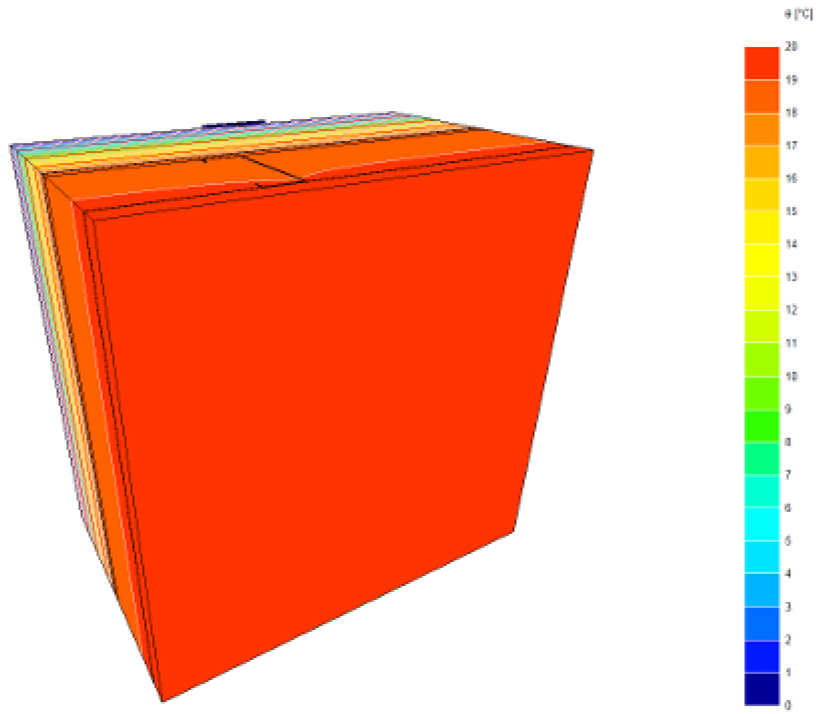


Figure 34 – Internal Temperature Gradient Diagram – Façade Creations

TRISCO – Input Data

TRISCO Data File: 05 vert.trc

Colours / Materials

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
13	MATERIAL				steel	– / –
24	MATERIAL				aluminium	– / –
42	MATERIAL				VCL	– / –
97	MATERIAL				y_wall	– / –
151	MATERIAL				insulation_0.035_W/mK	– / –
161	MATERIAL				gyproc_fireline	– / –
174	BC_SIMPL	HI_NORML	HOR		interior	– / –

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
185	BC_SIMPL	NIHIL			highly_ventilated_cavity	– / –

Material Properties

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
13	50.000	–	–	–	–	–	–	–	–	–
24	160.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
97	0.120	–	–	–	–	–	–	–	–	–
151	0.035	–	–	–	–	–	–	–	–	–
161	0.240	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL

Calculation Parameters

- **Iteration cycles:** 5
- **Maximum iterations per cycle:** 10,000
- **Maximum temperature difference within each cycle:** 0.0001 °C
- **Maximum temperature difference between cycles:** 0.001 °C
- **Heat flow divergence (total object):** 0.001 %
- **Heat flow divergence (worst node):** 1 %
- **Automatic recalculation of thermal values:** Enabled
- **Default temperature difference across airspace:** 10 °C

TRISCO – Calculation Results

TRISCO Data File: 05 vert.trc

- **Number of nodes:** 1,361,272
- **Heat flow divergence (total object):** 0.000512238 %
- **Heat flow divergence (worst node):** 0.987327 %
- **Total heat flow, Q:** 1.208 W
- **Interior temperature, ti:** 20.0000 °C
- **Exterior temperature, te:** 0.0000 °C

- **Area, A1:** 0.36 m²
- **Coordinate bounds:** Xmin=0, Xmax=126; Ymin=34, Ymax=34; Zmin=0, Zmax=123

Material Temperature Data

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
13	MATERIAL	Steel	18.6509	92	53	113	19.0509	92	85	0
24	MATERIAL	Aluminium	0.0621	46	1	0	0.0787	58	10	97
42	MATERIAL	VCL	19.0178	80	85	0	19.1908	126	86	0
43	MATERIAL	Breather	18.5071	0	48	114	18.6443	83	49	0
136	MATERIAL	reinforced_concrete_steel	18.5138	0	49	96	18.6787	81	53	0
151	MATERIAL	insulation_0.035_W/mK	0.0742	58	7	0	18.6374	83	48	0
161	MATERIAL	Plasterboard	19.0462	81	86	0	19.5791	126	92	0
174	BC_SIMPL	Interior	19.5173	84	92	0	19.5791	126	92	0
185	BC_SIMPL	highly_ventilated_cavity	0.0621	46	1	0	0.4334	126	7	68
200	EQUIMAT	cavity_non-vent_physical	18.5337	0	53	101	19.1718	126	85	24

Boundary Condition Flow Data

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
174	BC_SIMPL	Interior	–	1.2075	0.0000
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	1.2076

✅ **Note:** All results correspond to **Façade Creations**, providing detailed thermal analysis for vertical rail and cavity components.

Double Bracket Location – Horizontal Rail Ψ Value – Façade Creations

- Material Thermal Conductivity Diagram – Façade Creations
- Temperature Gradient Diagrams – Façade Creations

- Thermal Analysis Input Data – Façade Creations
- Thermal Analysis Output Data – Façade Creations

Thermal analysis was conducted using **TRISCO version 15.0.01**.

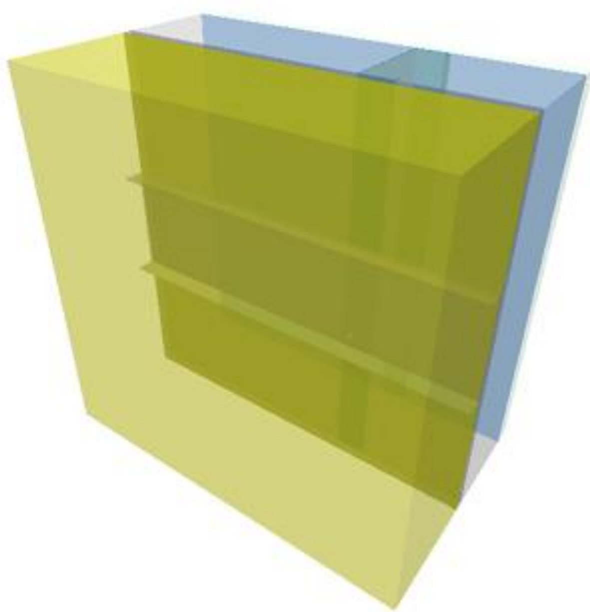
Summary:
A sample area of 600 mm × 600 mm was analyzed. The **Ψ value of the horizontal rail** for Façade Creations was determined to be **0.003 W/mK**.

Ψ Value Calculation – Façade Creations

Condition	Q [W]	ΔT [K]	l [m]	Q/ΔT [W/K]
With rail	1.238	20	0.600	0.062
Without rail	1.202	20	0.600	0.060

Ψ Value – Façade Creations:

$\Psi = l(Q_{rail}/\Delta T) - (Q_{no\ rail}/\Delta T) = 0.003$ W/mK



Material Thermal Conductivity Diagram – Façade Creations

- **Wall Section:** 600 mm × 600 mm
- **Heat Flow, Q:** 1.238 W

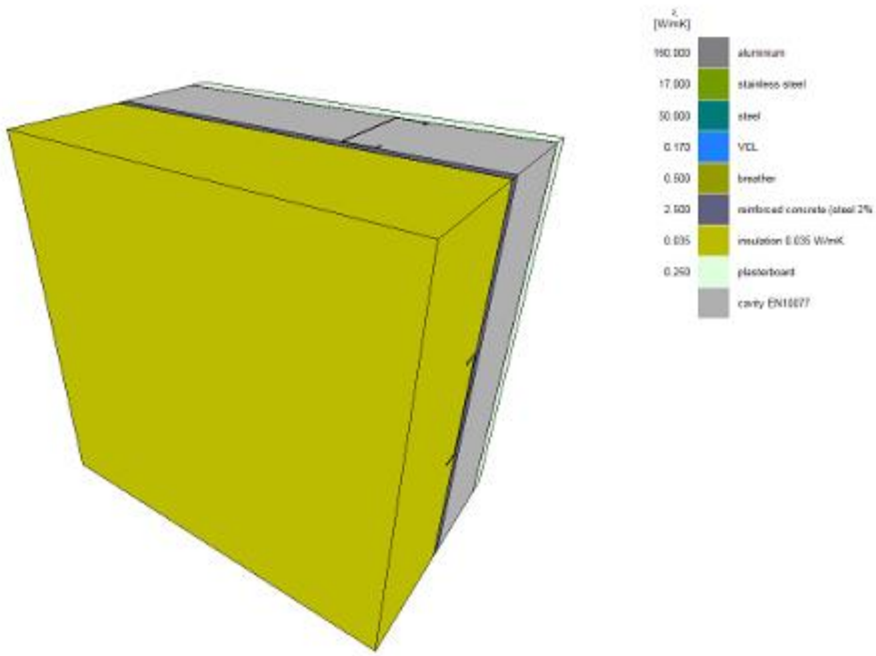


Figure 41 – External Material Thermal Conductivity Diagram – Façade Creations

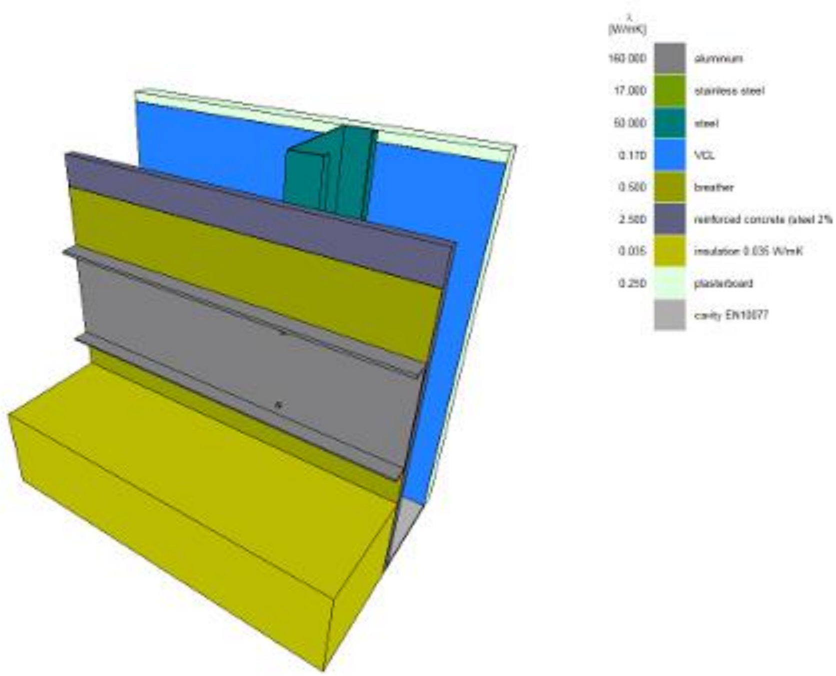


Figure 42 – Thermal Conductivity Diagram (Materials Cut Back for Clarity) – Façade Creations

Temperature Gradient Diagrams – Façade Creations

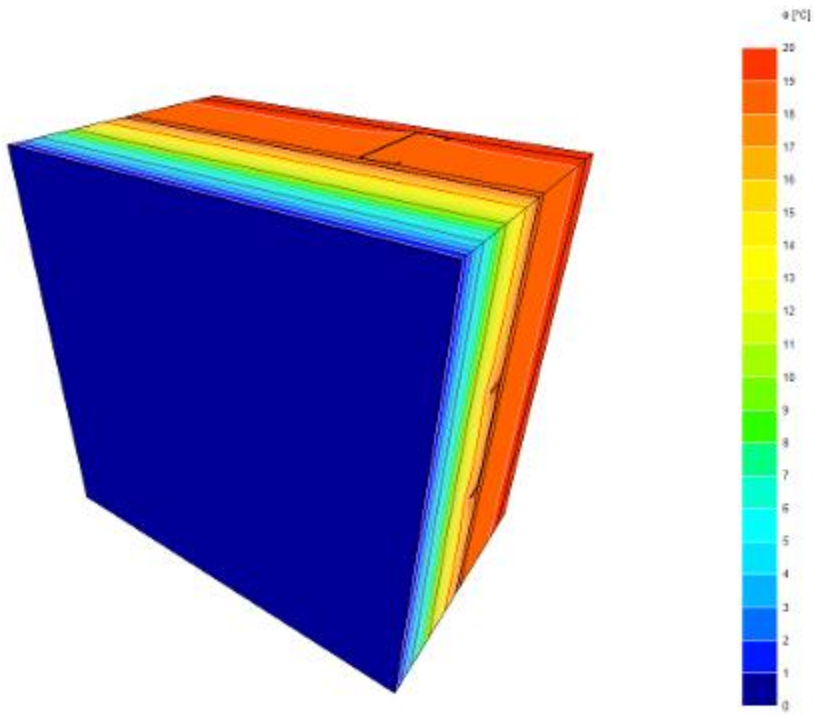


Figure 43 – External Temperature Gradient Diagram – Façade Creations

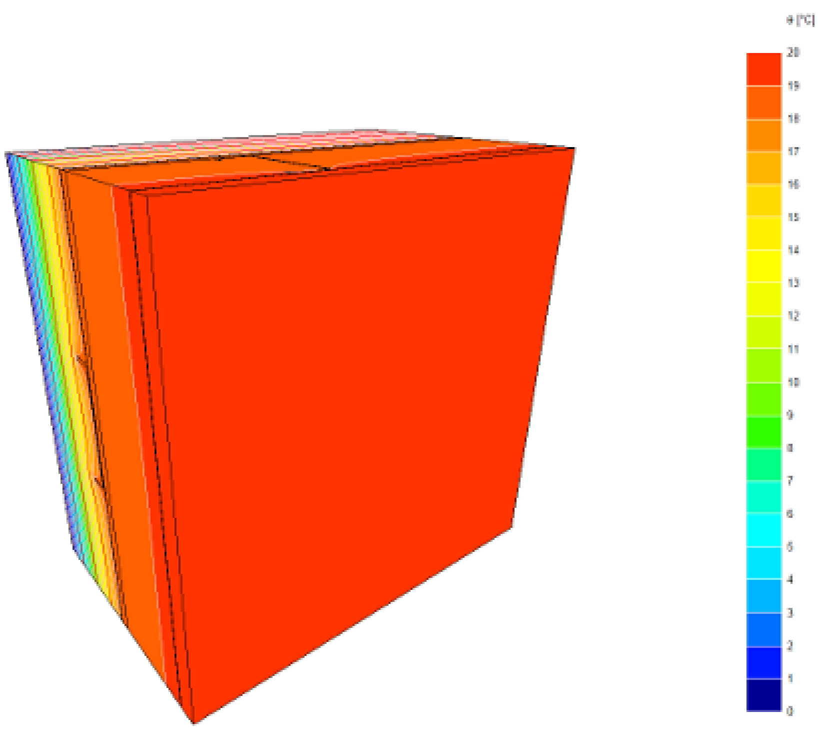


Figure 44 – Internal Temperature Gradient Diagram – Façade Creations

TRISCO – Input Data

TRISCO Data File: 06 load horiz.

Colours / Materials

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
8	MATERIAL				aluminium	– / –
11	MATERIAL				stainless_steel	– / –
13	MATERIAL				steel	– / –
42	MATERIAL				VCL	– / –
43	MATERIAL				breather	– / –
136	MATERIAL				reinforced_concrete_steel	– / –
151	MATERIAL				insulation_0.035_W/mK	– / –
161	MATERIAL				plasterboard	– / –
174	BC_SIMPL	HI_NORML	HOR		interior	– / –
185	BC_SIMPL	NIHIL			highly_ventilated_cavity	– / –
200	EQUIMAT	CAVITY	HOR	Yx	cavity_non-vent_physical	0.90 / 0.90

Material Properties

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000	–	–	–	–	–	–	–	–	–
11	17.000	–	–	–	–	–	–	–	–	–
13	50.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
43	0.500	–	–	–	–	–	–	–	–	–
136	2.500	–	–	–	–	–	–	–	–	–
151	0.035	–	–	–	–	–	–	–	–	–

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
161	0.250	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL
200	0.786	–	–	–	–	–	–	–	–	EN10077

Calculation Parameters

- **Iteration cycles:** 5
- **Maximum iterations per cycle:** 10,000
- **Maximum temperature difference within each cycle:** 0.0001 °C
- **Maximum temperature difference between cycles:** 0.001 °C
- **Heat flow divergence (total object):** 0.001 %
- **Heat flow divergence (worst node):** 1 %
- **Automatic recalculation of thermal values:** Enabled
- **Default temperature difference across airspace:** 10 °C

TRISCO – Calculation Results

TRISCO Data File: 06 load horiz.trc

- **Number of nodes:** 1,354,328
- **Heat flow divergence (total object):** 0.000974509 %
- **Heat flow divergence (worst node):** 0.524848 %
- **Total heat flow, Q:** 1.238 W
- **Interior temperature, ti:** 20.0000 °C
- **Exterior temperature, te:** 0.0000 °C
- **Area, A1:** 0.36 m²
- **Coordinate bounds:** Xmin=0, Xmax=126; Ymin=34, Ymax=34; Zmin=0, Zmax=123

Material Temperature Data – Façade Creations

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
8	MATERIAL	aluminium	18.4441	0	40	43	18.5055	85	48	60
11	MATERIAL	stainless_steel	18.4952	86	46	74	18.6026	85	58	48
13	MATERIAL	steel	18.5480	92	53	63	19.0254	92	85	123
42	MATERIAL	VCL	18.9723	80	85	62	19.1765	0	86	123

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
43	MATERIAL	breather	18.4546	0	48	43	18.6174	83	49	123
136	MATERIAL	reinforced_concrete_steel	18.4671	0	49	76	18.6513	81	53	123
151	MATERIAL	insulation_0.035_W/mK	0.4362	0	7	0	18.6107	83	48	123
161	MATERIAL	plasterboard	19.0022	81	86	62	19.5719	0	92	123
174	BC_SIMPL	interior	19.4956	84	92	62	19.5719	0	92	123
185	BC_SIMPL	highly_ventilated_cavity	0.4362	0	7	0	0.4559	89	7	69
200	EQUIMAT	cavity_non-vent_physical	18.4904	0	53	53	19.1571	0	85	123

Boundary Condition Flow Data – Façade Creations

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
174	BC_SIMPL	interior	–	1.2381	0.0000
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	1.2381

✅ **Note:** These results correspond to **Façade Creations**, providing detailed thermal performance analysis for the horizontal rail section.

Single Bracket Location – Horizontal Rail Ψ Value – Façade Creations

- Material Thermal Conductivity Diagram – Façade Creations
- Temperature Gradient Diagrams – Façade Creations
- Thermal Analysis Input Data – Façade Creations
- Thermal Analysis Output Data – Façade Creations

Thermal analysis was conducted using **TRISCO version 15.0.01**.

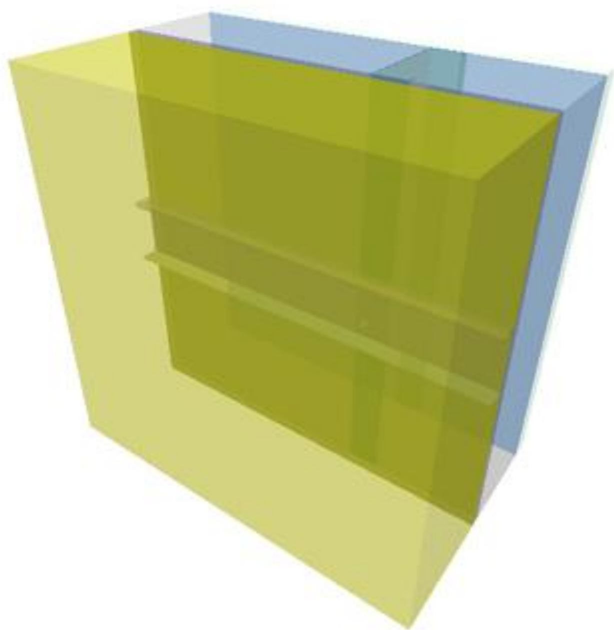
Summary:
A sample area of 600 mm × 600 mm was analyzed. The **Ψ value of the horizontal rail** for **Façade Creations** was determined to be **0.003 W/mK**.

Ψ Value Calculation – Façade Creations

Condition	Q [W]	ΔT [K]	l [m]	Q/ΔT [W/K]
With rail	1.234	20	0.600	0.062
Without rail	1.202	20	0.600	0.060

Ψ Value – Façade Creations:

Ψ=l(Qrail/ΔT)−(Qno rail/ΔT)=0.003 W/mK



Material Thermal Conductivity Diagram – Façade Creations

- **Wall Section:** 600 mm × 600 mm
- **Heat Flow, Q:** 1.234 W

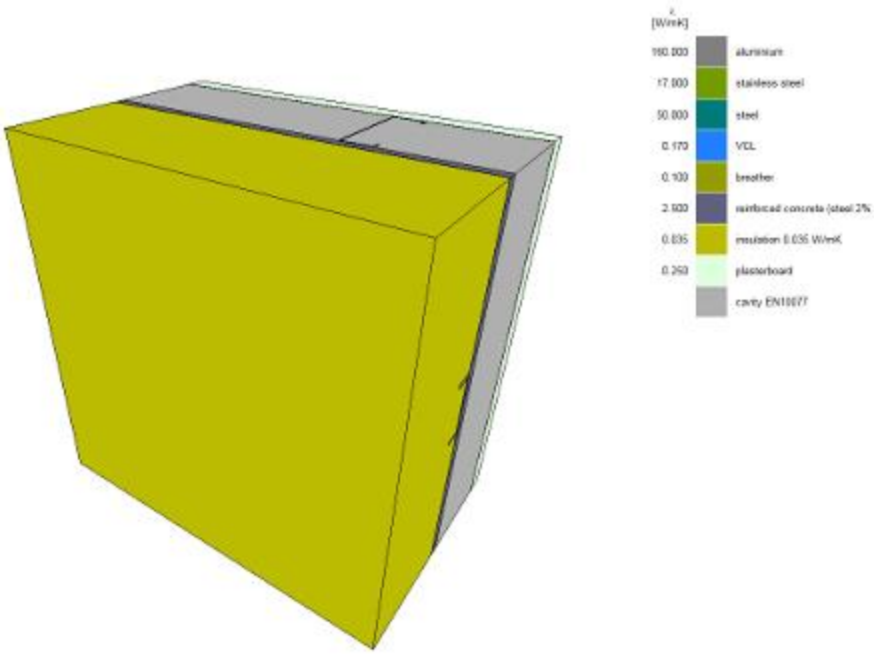


Figure 51 – External Material Thermal Conductivity Diagram – Façade Creations

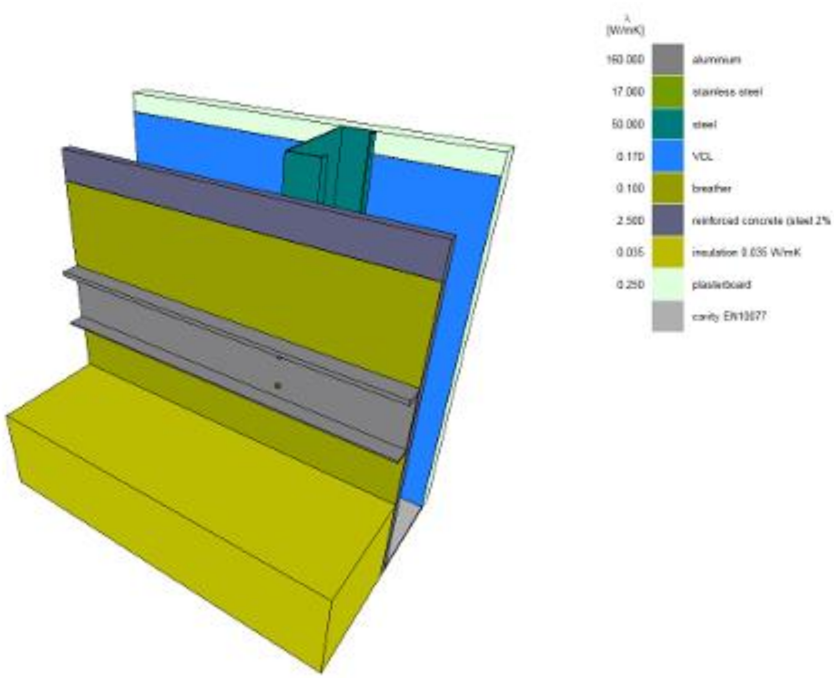


Figure 52 – Thermal Conductivity Diagram (Materials Cut Back for Clarity) – Façade Creations

Temperature Gradient Diagrams – Façade Creations

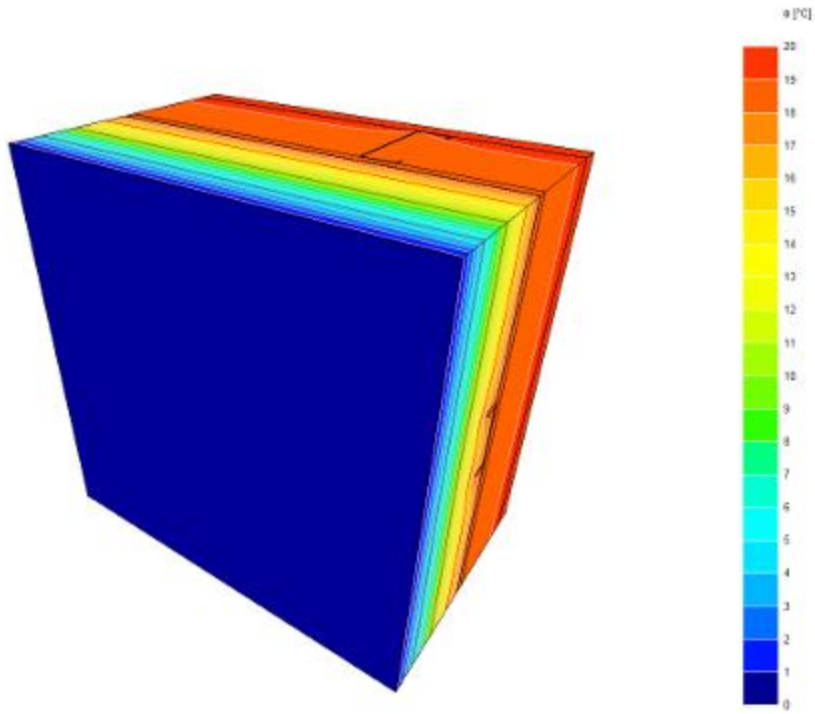


Figure 53 – External Temperature Gradient Diagram – Façade Creations

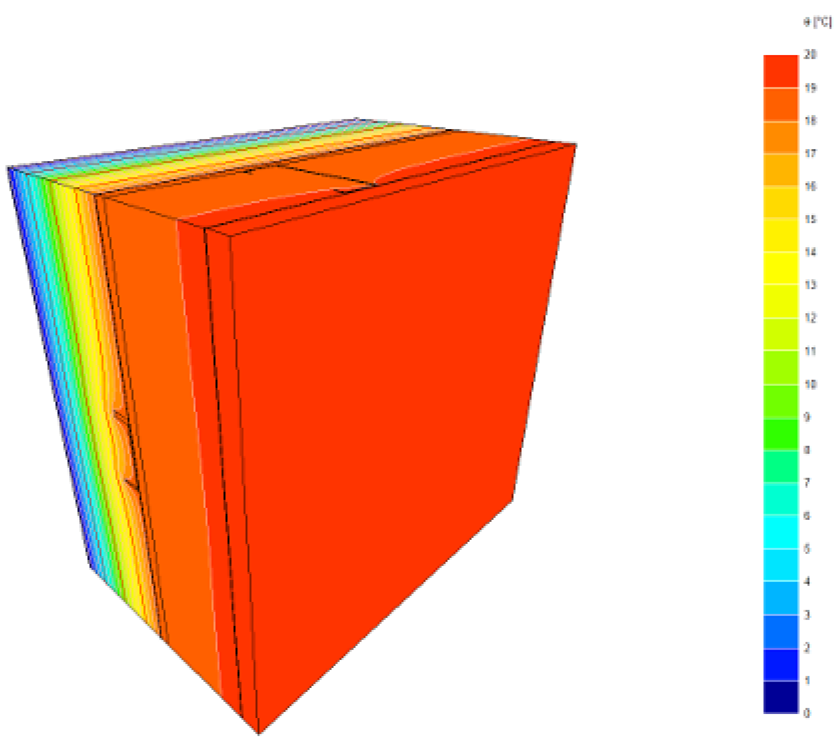


Figure 54 – Internal Temperature Gradient Diagram – Façade Creations

TRISCO – Input Data

TRISCO Data File: 07 res horiz.trc

Colours / Materials

Col	Type	Subtype	Phys. flow	Geom. flow	Name	eps1 / eps2
8	MATERIAL				aluminium	– / –
11	MATERIAL				stainless_steel	– / –
13	MATERIAL				steel	– / –
42	MATERIAL				VCL	– / –
43	MATERIAL				breather	– / –
136	MATERIAL				reinforced_concrete_steel	– / –
151	MATERIAL				insulation_0.035_W/mK	– / –
161	MATERIAL				plasterboard	– / –
174	BC_SIMPL	HI_NORML	HOR		interior	– / –
185	BC_SIMPL	NIHIL			highly_ventilated_cavity	– / –
200	EQUIMAT	CAVITY	HOR	Yx	cavity_non-vent_physical	0.90 / 0.90

Material Properties

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
8	160.000	–	–	–	–	–	–	–	–	–
11	17.000	–	–	–	–	–	–	–	–	–
13	50.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
43	0.100	–	–	–	–	–	–	–	–	–
136	2.500	–	–	–	–	–	–	–	–	–

Col	λ [W/mK]	ε [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
151	0.035	–	–	–	–	–	–	–	–	–
161	0.250	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL
200	0.787	–	–	–	–	–	–	–	–	EN10077

Calculation Parameters

- **Iteration cycles:** 5
- **Maximum iterations per cycle:** 10,000
- **Maximum temperature difference within each cycle:** 0.0001 °C
- **Maximum temperature difference between cycles:** 0.001 °C
- **Heat flow divergence (total object):** 0.001 %
- **Heat flow divergence (worst node):** 1 %
- **Automatic recalculation of thermal values:** Enabled
- **Default temperature difference across airspace:** 10 °C

TRISCO – Calculation Results – Façade Creations

TRISCO Data File: 07 res horiz.trc

- **Number of Nodes:** 1,332,484
- **Heat Flow Divergence (Total Object):** 0.000999852 %
- **Heat Flow Divergence (Worst Node):** 0.164467 %
- **Q:** 1.234 W
- **ti:** 20.0000 °C
- **te:** 0.0000 °C
- **Area, A1:** 0.36 m²
- **Coordinates:** Xmin=0, Xmax=126; Ymin=34, Ymax=34; Zmin=0, Zmax=121

Temperature Range per Material – Façade Creations

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
8	MATERIAL	aluminium	18.3892	0	40	50	18.4507	86	48	56
11	MATERIAL	stainless_steel	18.4418	85	46	65	18.6007	85	58	55
13	MATERIAL	Steel	18.5476	92	53	61	19.0301	92	85	121

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
42	MATERIAL	VCL	18.9789	80	85	60	19.1765	21	86	121
43	MATERIAL	breather	18.3993	0	48	50	18.6232	83	49	121
136	MATERIAL	reinforced_concrete_steel	18.4485	0	49	60	18.6571	81	53	121
151	MATERIAL	insulation_0.035_W/mK	0.4342	0	7	0	18.5895	83	48	121
161	MATERIAL	plasterboard	19.0085	81	86	60	19.5719	18	92	121
174	BC_SIMPL	interior	19.4987	84	92	60	19.5719	18	92	121
185	BC_SIMPL	highly_ventilated_cavity	0.4342	0	7	0	0.4603	88	7	61
200	EQUIMAT	cavity_non-vent_physical	18.4734	0	53	60	19.1572	22	85	121

Heat Flow Summary – Façade Creations

Col	Type	Name	ta [°C]	Flow In [W]	Flow Out [W]
174	BC_SIMPL	interior	–	1.2345	0.0000
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	1.2345

Centre Area for Deduction to Ascertain Ψ Value of Rails

Material Thermal Conductivity Diagram

- **Wall Section:** 600 mm × 600 mm
- **Q:** 1.202 W

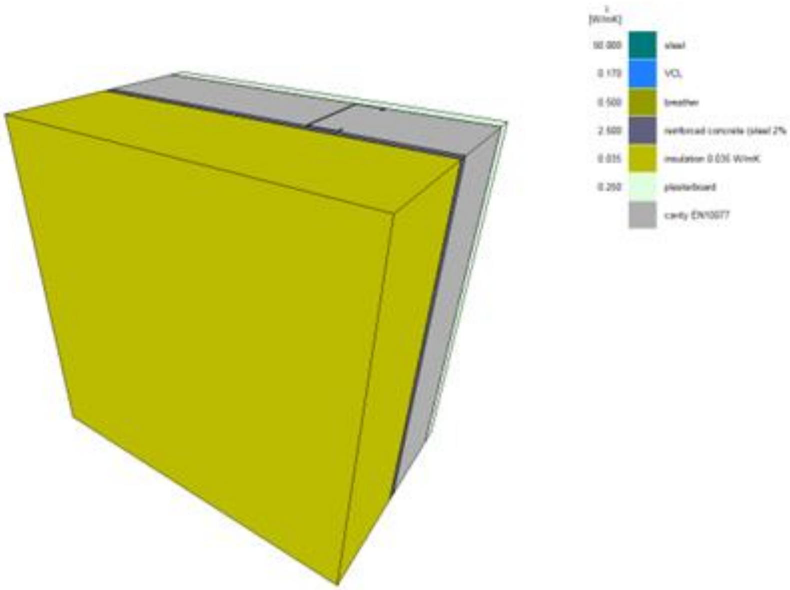


Figure 61: External material thermal conductivity diagram – Façade Creations

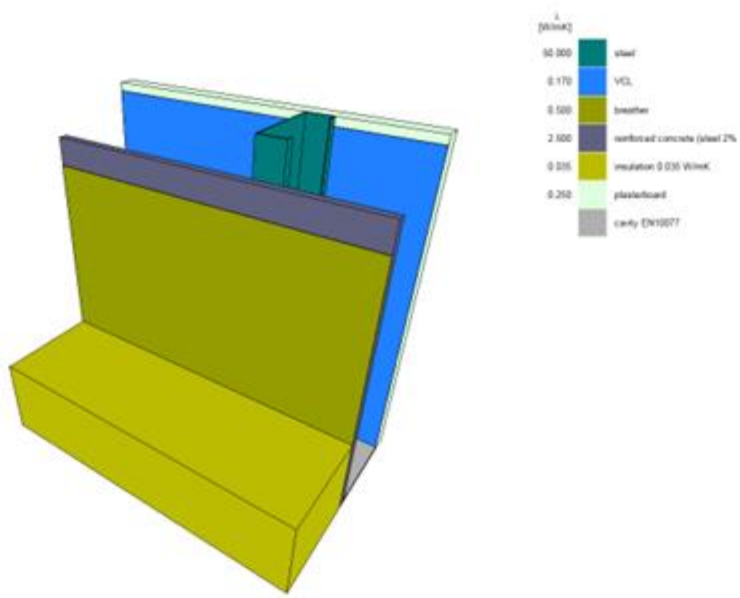


Figure 62: Thermal conductivity diagram – materials cut back for clarity – Façade Creations

Temperature Gradient Diagrams – Façade Creations

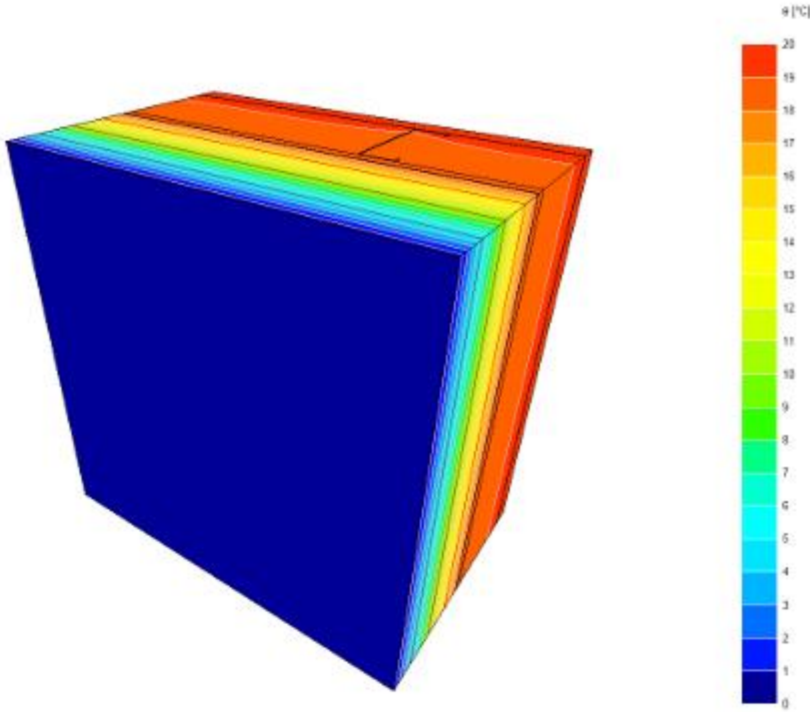


Figure 63: External temperature gradient diagram – Façade Creations

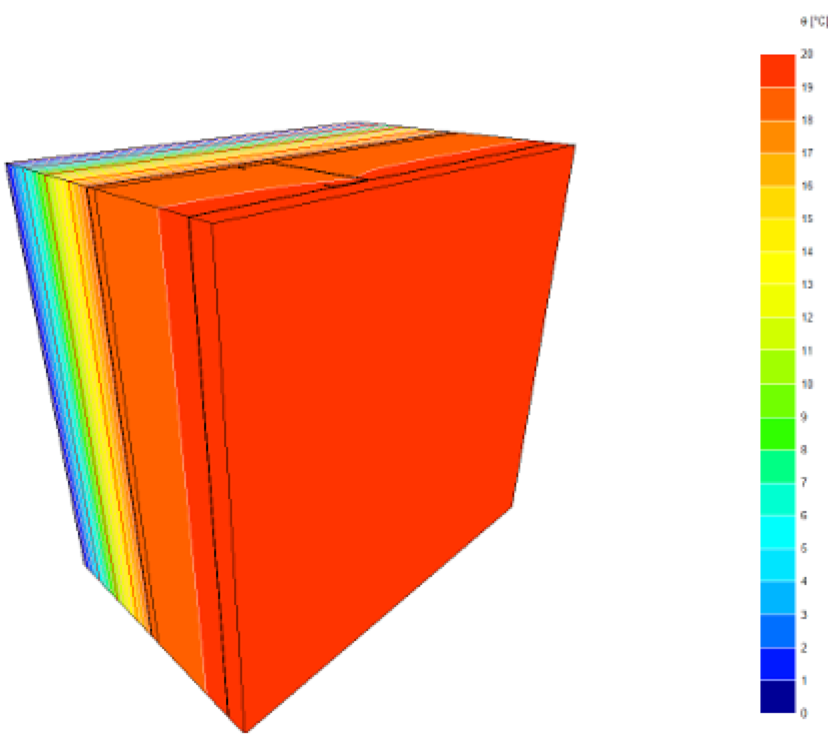


Figure 64: Internal temperature gradient diagram – Façade Creations

TRISCO – Input Data – Façade Creations

TRISCO Data File: 08 cen.trc

Material Colours

Col	Type	Subtype	Phys. Flow	Geom. Flow	Name	eps1 / eps2
13	MATERIAL	–	–	–	steel	–
42	MATERIAL	–	–	–	VCL	–
43	MATERIAL	–	–	–	breather	–
136	MATERIAL	–	–	–	reinforced_concrete_steel	–
151	MATERIAL	–	–	–	insulation_0.035_W/mK	–
161	MATERIAL	–	–	–	plasterboard	–
174	BC_SIMPL	HI_NORML	HOR	–	interior	–
185	BC_SIMPL	NIHIL	–	–	highly_ventilated_cavity	–
200	EQUIMAT	CAVITY	HOR Yx	–	cavity_non-vent_physical	0.90 / 0.90

Thermal Properties

Col	Lambda [W/mK]	eps [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
13	50.000	–	–	–	–	–	–	–	–	–
42	0.170	–	–	–	–	–	–	–	–	–
43	0.500	–	–	–	–	–	–	–	–	–
136	2.500	–	–	–	–	–	–	–	–	–
151	0.035	–	–	–	–	–	–	–	–	–
161	0.250	–	–	–	–	–	–	–	–	–
174	–	–	20.0	7.70	0	–	–	–	–	EN10077
185	–	–	0.0	7.70	0	–	–	–	–	NIHIL

Col	Lambda [W/mK]	eps [-]	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	hc [W/m²K]	Pc [W/m]	tr [°C]	Standard
200	0.785	–	–	–	–	–	–	–	–	EN10077

Calculation Parameters

- Iteration cycles: 5
- Maximum iterations per cycle: 10,000
- Maximum temperature difference per iteration cycle: 0.0001 °C
- Maximum temperature difference between cycles: 0.001 °C
- Heat flow divergence (total object): 0.001 %
- Heat flow divergence (worst node): 1 %
- Automatic recalculation of thermal values
- Default temperature difference across airspace: 10 °C

TRISCO – Calculation Results – Façade Creations

TRISCO Data File: 08 cen.trc

- **Number of nodes:** 1,354,328
- **Heat flow divergence (total object):** 0.000987 %
- **Heat flow divergence (worst node):** 0.104 %
- **Q:** 1.202 W
- **ti:** 20.0000 °C
- **te:** 0.0000 °C
- **A1:** 0.36 m²
- **Xmin/Xmax:** 0 / 126
- **Ymin/Ymax:** 34 / 34
- **Zmin/Zmax:** 0 / 123

Material Temperature Range

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
13	MATERIAL	Steel	18.6572	92	53	0	19.0554	92	85	54
42	MATERIAL	VCL	19.0225	80	85	0	19.1941	126	86	50
43	MATERIAL	Breather	18.5132	0	48	0	18.6509	83	49	76
136	MATERIAL	reinforced_concrete_steel	18.5198	0	49	0	18.6851	81	53	61
151	MATERIAL	insulation_0.035_W/mK	0.4327	0	7	13	18.6440	83	48	63
161	MATERIAL	Plasterboard	19.0508	81	86	0	19.5808	126	92	63

Col	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
174	BC_SIMPL	Interior	19.5197	84	92	0	19.5808	126	92	63
185	BC_SIMPL	highly_ventilated_cavity	0.4327	0	7	13	0.4343	87	7	119
200	EQUIMAT	cavity_non-vent_physical	18.5397	0	53	0	19.1752	126	85	55

Flow Summary

Col	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
174	BC_SIMPL	interior	–	1.2018	0.0000
185	BC_SIMPL	highly_ventilated_cavity	–	0.0000	1.2018