Certificate No. FS 564908

WINTECH
FAÇADE ENGINEERING CONSULTANCY

Camel Glass

U-value Analysis of Timber Door

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1.0 Introduction

1.1 This report has been prepared by Mr Osama Alsheikh of Wintech Limited, following instruction from Mr Bruce Dudman of Camel Glass and Joinery Limited.

1.2 This report has been produced to calculate the thermal transmittance (U-value) of a single-open-in timber frame door.

1.3 Two-dimensional steady-state analyses have been undertaken to assess the overall thermal performance of the door.

2.0 Software

2.1 2-Dimensional Analysis

2.1.1 The software package 'Flixo' (version 8.0.923.1, Infomind), has been used to carry out the 2-dimensional steady-state simulations in order to obtain the U-values of the door components necessary to calculate the total U-value of the door. The 2-dimensional geometry is constructed by importing drawings from AutoCAD in “dxf” format. The process reduces curves to segmented lines, within limits set by the user. The software has been validated using the 10 examples within EN ISO 10077-2 2012.

3.0 References

- EN ISO 10077-1:2017 Thermal performance of windows, doors and shutters. Calculation of thermal transmittance – Part 1: General.

- EN ISO 10077-2:2017 Thermal performance of windows, doors and shutters — Calculation of thermal transmittance —Part 2: Numerical methods for frames.

4.0 Methodology

4.1 The U-value calculation was based on two typical details of door construction and product data sheet provided by Camel Glass Limited. Refer to Appendix B.

4.2 The two details have been analysed under the environment's criteria defined in BS EN ISO 10077-2:2017 with the following ambient air temperature conditions:

- External Temperature: 0 °C
- Internal Temperature: 20 °C

5.0 Symbols, Units

Table5.1: Symbols and Units

Symbol	Description	Unit
Qt	Total heat flow from simulation	W
A	Area of model	m^2
ΔT	Temperature difference	K

6.0 U Value Result

6.1 In order to determine the overall U-value of the door, the U-value of the frame is calculated first for the head, the jambs, and the cill separately.

6.2 The head and the jambs details are similar (Sec A-A), therefore the U-value of the frame at both is identical and equal to 1.3 W/m2.K .

6.3 The U-value at the cill (Sec B-B) was calculated and found to be 3.92 W/m2.K .

6.4 The Panel incorporated in the door has a centre U-value of 0.486 W/m2.K .

6.5 The overall U-value of the door is 0.79 W/m2.K .

6.6 See Appendix A for calculation sheets.

Appendix A

- U Value Reference Elevations, details and Calculation Sheets

Calculation of the door thermal transmittance

Formula

$U_{tot} = (\Sigma U_f . A_f + \Sigma U_p . A_p) / A_{tot}$

Project Name: Camel Glass Door U-value analysis

Where:

- U_{tot} is the thermal transmittance whole door, in W/m²K
- U_f is the thermal transmittance of the frame section (including Ψ), in W
- A_f is the projected width of the frame section, in m²
- U_p is the centre panel thermal transmittance, in W/m²K
- A_p is the visible width of the panel, in m²
- A_{tot} is the total area of the door, in m²

Size: Width 1.275 m, Height 2.425 m

Input:

Framing:

Ref	Width	Height	Qty	Area	U-Value	U.A
Sec A-A	0.102	5.713	1	0.583	1.30	0.758
SecB-B	0.104	1.275	1	0.133	3.92	0.520

Panel:

Ref	Width	Height	Qty	Area	U-Value	U.A
P1	1.071	2.219	1	2.377	0.486	1.155

Total Frame Area 0.715 m²
Total Frame Heat Loss 1.277 W/k

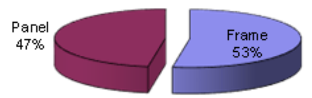
Total panel Area 2.377 m²
Total panel Heat Loss 1.155 W/k

Results:

Total Area: **3.092 m²**
Total Heat Loss: **2.432 W/k**

U_{tot} = 0.79 W/m²K

% Heat Loss



Calculation of the door frame head and jambs thermal transmittance

Project Name: Camel Glass door U-value

Detail Ref: Sec A-A

Formula

$$U_f = (L_f^{2D} - U_p.b_p)/b_f$$

Where:
- U_f is the thermal transmittance of the frame section (including Ψ), in W/m^{2}K
- L_f^{2D} is the thermal conductance of the section, in W/(m.K)
- b_f is the projected width of the frame section, in m
- U_p is the centre panel thermal transmittance, in W/m^{2}K
- b_p is the visible width of the panel, in m

$$L_f^{2D} = q_{tot}/\Delta\theta$$

Where:
- L_f^{2D} is the thermal conductance of the section, in W/(m.K)
- q_{tot} is the simulated heat flow through the detail, in W/m
- $\Delta\theta$ is the internal (t_i) to external (t_o) temperature difference, in K

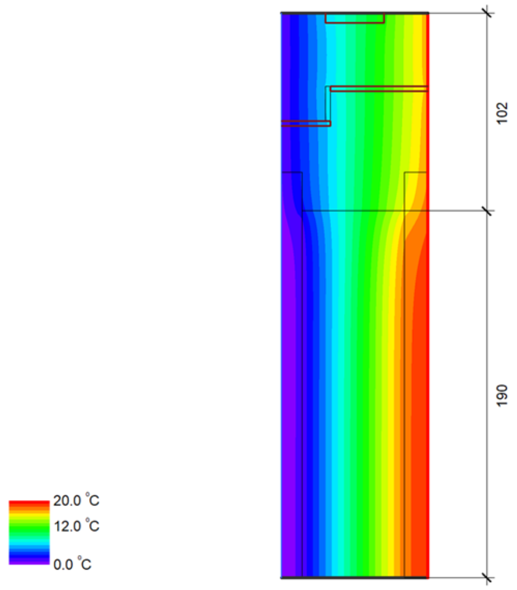
Input:

q_{tot}	=	4.526	W/m
U_p	=	0.486	W/m^{2}K
$\Delta\theta$	=	20	K
b_p	=	0.19	m
b_f	=	0.103	m

Results:

L_f^{2D} = 0.226 W/m.K

U_f = 1.30 W/m^{2}K



Calculation of the door frame cill thermal transmittance

Project Name: Camel Glass door U-value

Detail Ref: Sec B-B

Formula

$$U_f = (L_f^{2D} - U_p.b_p)/b_f$$

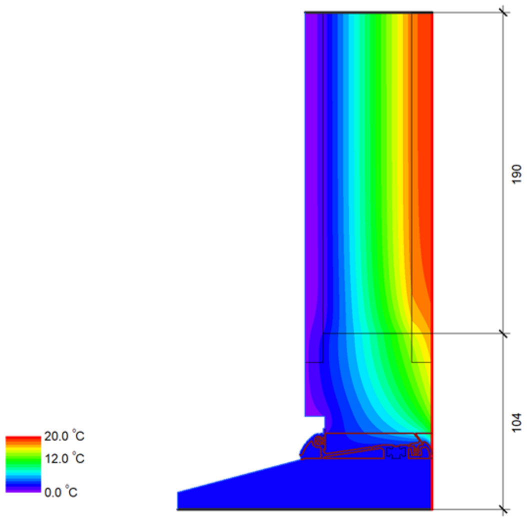
Where:
- U_f is the thermal transmittance of the frame section (including Ψ), in W/m²K
- L_f^{2D} is the thermal conductance of the section, in W/(m.K)
- b_f is the projected width of the frame section, in m
- U_p is the centre panel thermal transmittance, in W/m²K
- b_p is the visible width of the panel, in m

$$L_f^{2D} = q_{tot}/\Delta\theta$$

Where:
- L_f^{2D} is the thermal conductance of the section, in W/(m.K)
- q_{tot} is the simulated heat flow through the detail, in W/m
- $\Delta\theta$ is the internal (t_i) to external (t_o) temperature difference, in K

Input:

q_{tot}	=	9.996	W/m
U_p	=	0.486	W/m²K
$\Delta\theta$	=	20	K
b_p	=	0.19	m
b_f	=	0.104	m

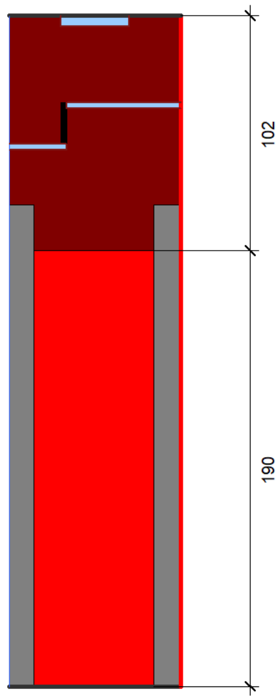


Results:

L_f^{2D} = 0.500 W/m.K

U_f = 3.92 W/m²K

Sec A-A

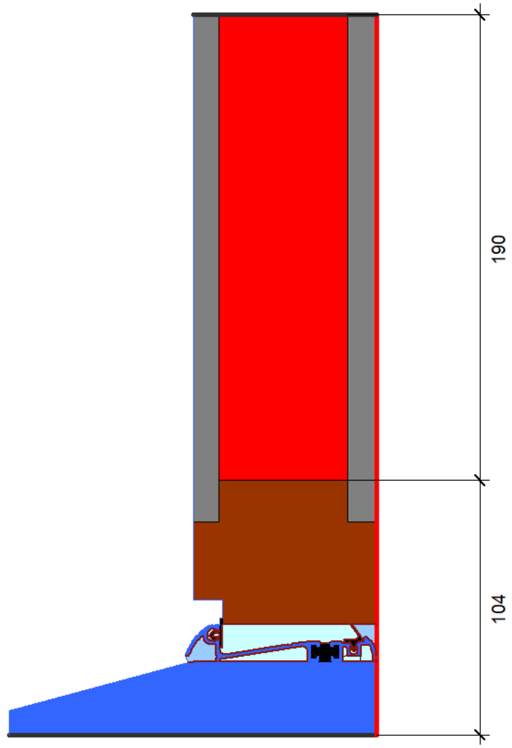


Material	λ[W/(m·K)]	ε
Accoya Timber	0.120	0.900
EPDM	0.250	0.900
EXtruded Polystrene	0.031	0.900
Slightly ventilated air cavity **		
Tricoya	0.114	0.900

** EN ISO 10077-2:2017, 6.4.3/anisotrop

Boundary Condition	$q[W/m^2]$	$\theta[^{\circ}C]$	$R[(m^2 \cdot K)/W]$	ε
Epsilon 0.9				0.900
Exterior		0.000	0.040	
Interior, normal, horizontal		20.000	0.130	
Symmetry/Model section	0.000			

Sec B-B



Material	λ[W/(m·K)]	ε
Accoya timber	0.120	0.900
Aluminium	160.000	0.900
EPDM	0.250	0.900
Extruded ploystrene	0.031	0.900
Slightly ventilated air cavity **		
Tricoya	0.114	0.900
Unventilated air cavity **		

** EN ISO 10077-2:2017, 6.4.3/anisotrop

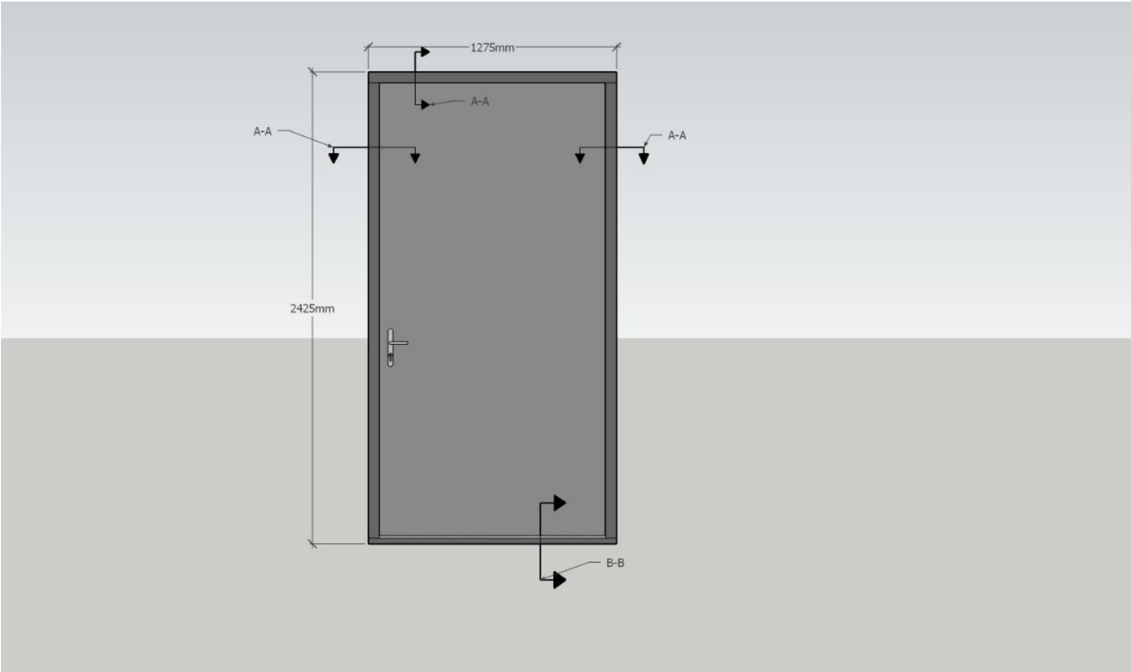
Boundary Condition	$q[W/m^2]$	$\theta[^\circ C]$	$R[(m^2 \cdot K)/W]$	ε
Epsilon 0.9				0.900
Exterior		0.000	0.040	
Interior, normal, horizontal		20.000	0.130	
Symmetry/Model section	0.000			

Appendix B

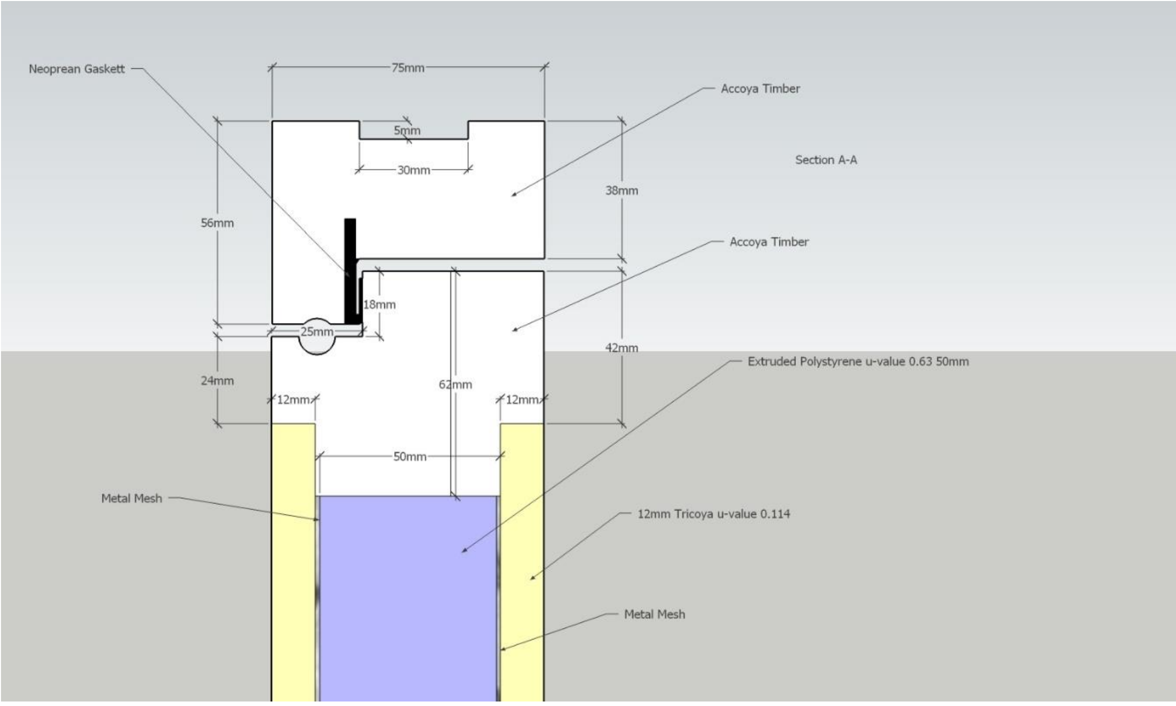
- Thermal properties of the door components

Component	Thermal conductivity (W/m2.K)
Accoya timber frame	0.12
Smart aluminium cill ETC457	160
Tricoya timber panel facings	0.114
Extruded polystyrene Insulation	0.031
EPDM gasket seals	0.25

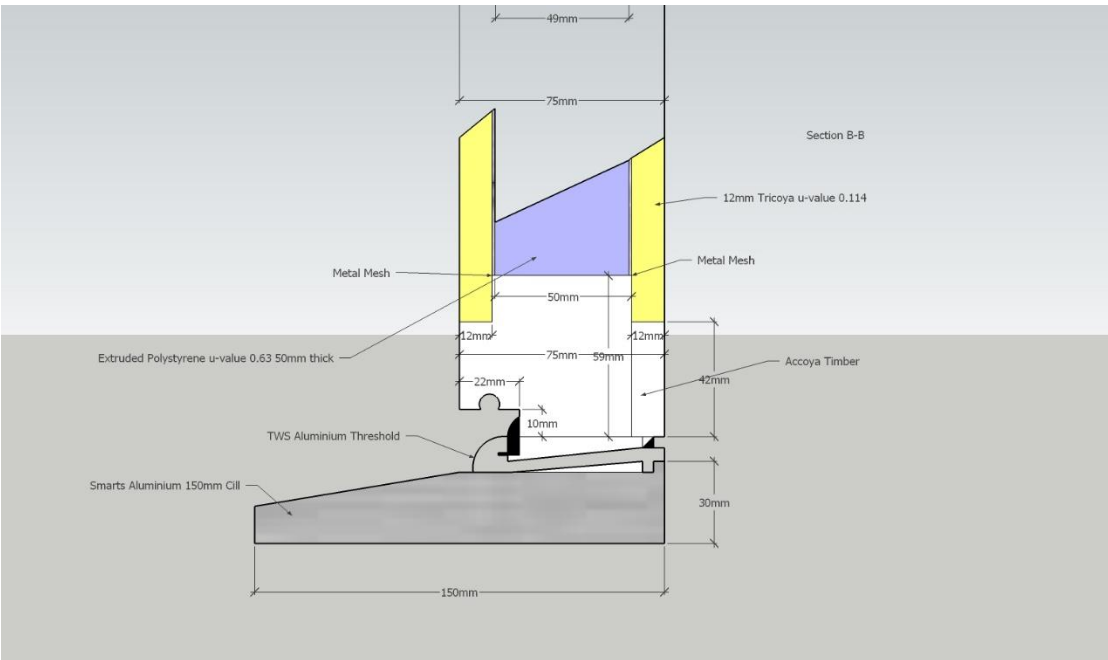
- **Door Elevation**



- **Sec A-A**


Neoprean Gaskett
75mm
Accoya Timber
5mm
30mm
Section A-A
38mm
56mm
Accoya Timber
18mm
25mm
42mm
Extruded Polystyrene u-value 0.63 50mm
24mm
12mm
62mm
12mm
50mm
Metal Mesh
12mm Tricoya u-value 0.114
Metal Mesh

- **Sec B-B**


49mm
75mm
Section B-B
12mm Tricoya u-value 0.114
Metal Mesh
Metal Mesh
50mm
12mm
12mm
Extruded Polystyrene u-value 0.63 50mm thick
75mm
59mm
Accoya Timber
22mm
42mm
10mm
TWS Aluminium Threshold
Smarts Aluminium 150mm Cill
30mm
150mm