U-Value Calculation Report 02 – STIRA Standard Loft Ladder System

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Rev No.	Description	Comment	Calculations Prepared by	Checked by	Date
0	Final		Tintu Michael MSc Physics	Michael Molloy B.Eng. (Hons) MIEI	27-10-23

1 Introduction

This report was commissioned to calculate the wall u-value for an attic roof with STIRA Standard Loft Ladder System.

2 Summary of Results

Results	
Type	**U value**
STIRA Standard Loft Ladder System installed in typical ceiling (below attic)	0.17 $W/m^2 K$

3 Method of U-Value Calculation

3.1 U-value calculation

The U-value calculation was based on BRE Document 'BR 443 Conventions for U-value calculations 2019 Edition'.

As per guidance provided in BR 443:

The point thermal transmittance for discrete fixing brackets (χ) which penetrate an insulation layer was calculated according to BR 497 & BS EN ISO 10211 using Trisco v15 software by Physibel.

The construction detail was modelled as shown in the following pages, this report is valid only for the constructions detail as described here and elsewhere in this report.

Material thermal properties are based on product agrément certificates or in the absence of specific material properties, standard material properties were used from sources such as CIBSE guide A, I.S EN ISO 10456, BS EN ISO 6946 & BR443.

U-values are calculated to take account of heat loss through building elements and take account of repeating thermal bridges, in this case rainscreen brackets.

Heat flow due to non-repeating thermal bridges (e.g. junctions of floor and roof with the external wall) will need to be determined separately and do not form part of this report.

All drawings in this report are for illustration purposes only.

3.2 Basis of U-value calculation

The calculations are based on information detailed below as provided to BET by the client:

- The calculations are based on an average floor area provided by Central Statistics Office Ireland.
- As per Central Statistics Office the average floor area for a dwelling is 113m^2. In this analysis we have assumed all dwellings as two-story dwelling to strain the assessment i.e., 57m^2.
- Area of the door in the analysis is 0.67m^2 (1.218m x 0.55m).
- Resulting point correction of 0.67m^2 per 57m^2 is 0.01 per m^2.
- The insulation used in the attic space is 300mm mineral wool with 0.044 W/mK.
- Airgap corrections used in the calculation is level 0 i.e., there is no air void within the insulation or only minor air voids (not exceeding 5mm) are present.

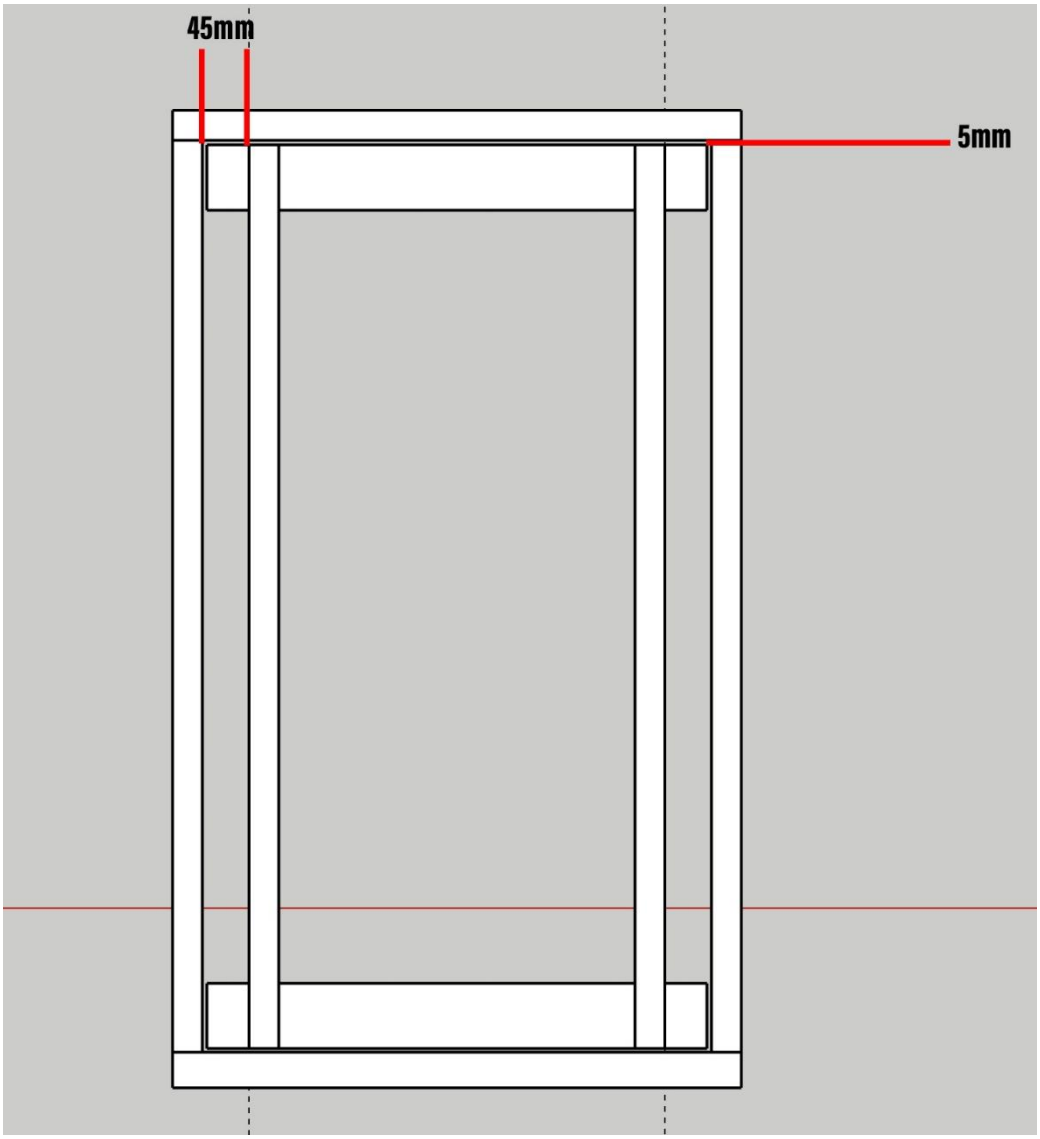

Figure 1

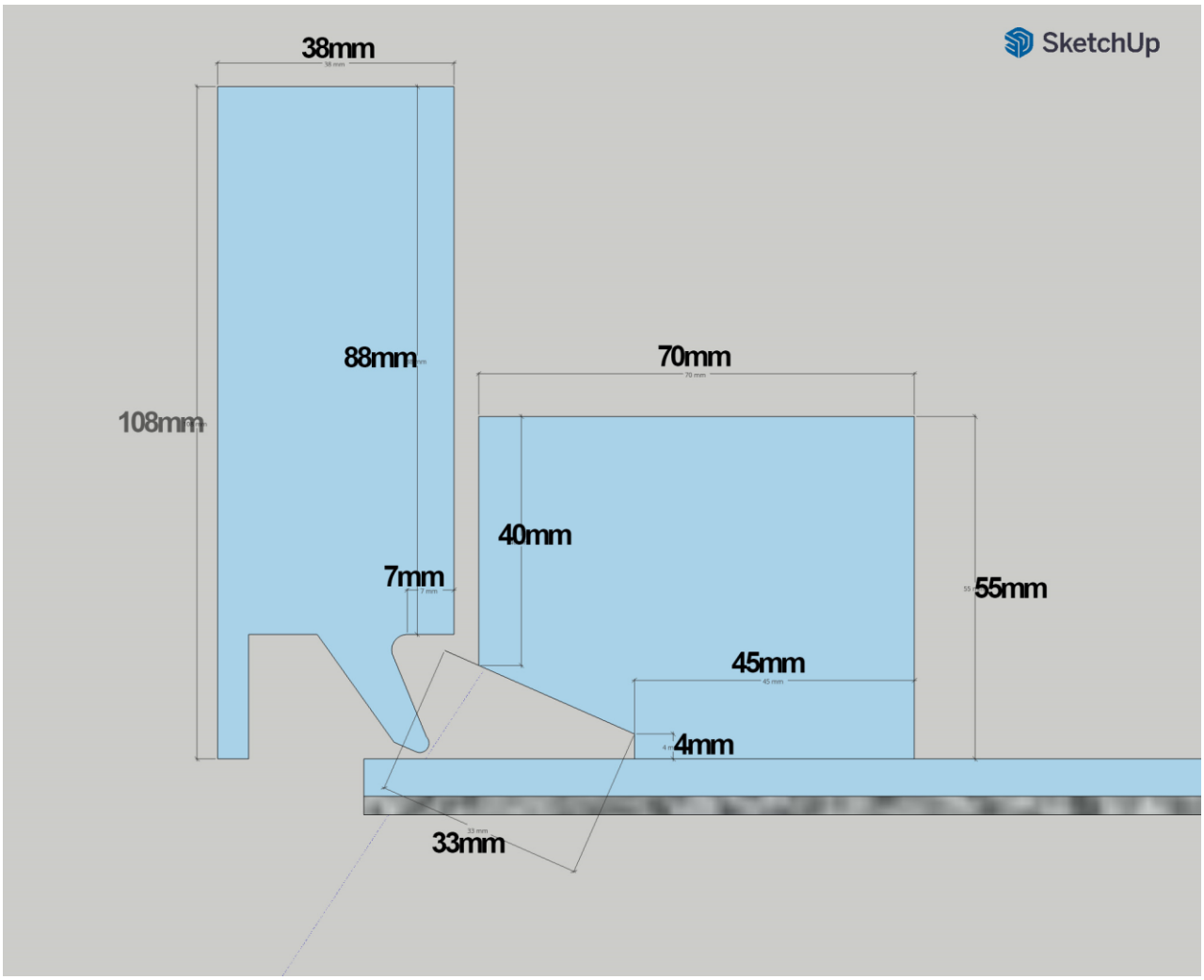

Figure 2 Dimensions

4 Standard Stira

4.1 Point Thermal Bridge χ-value Calculation.

The Point Thermal Bridge (χ-value) for the bracket that penetrates the outer insulation layer was calculated as follows:

4.1.1 Graphics

The thermal model is constructed with a plane of symmetry surrounding the door:

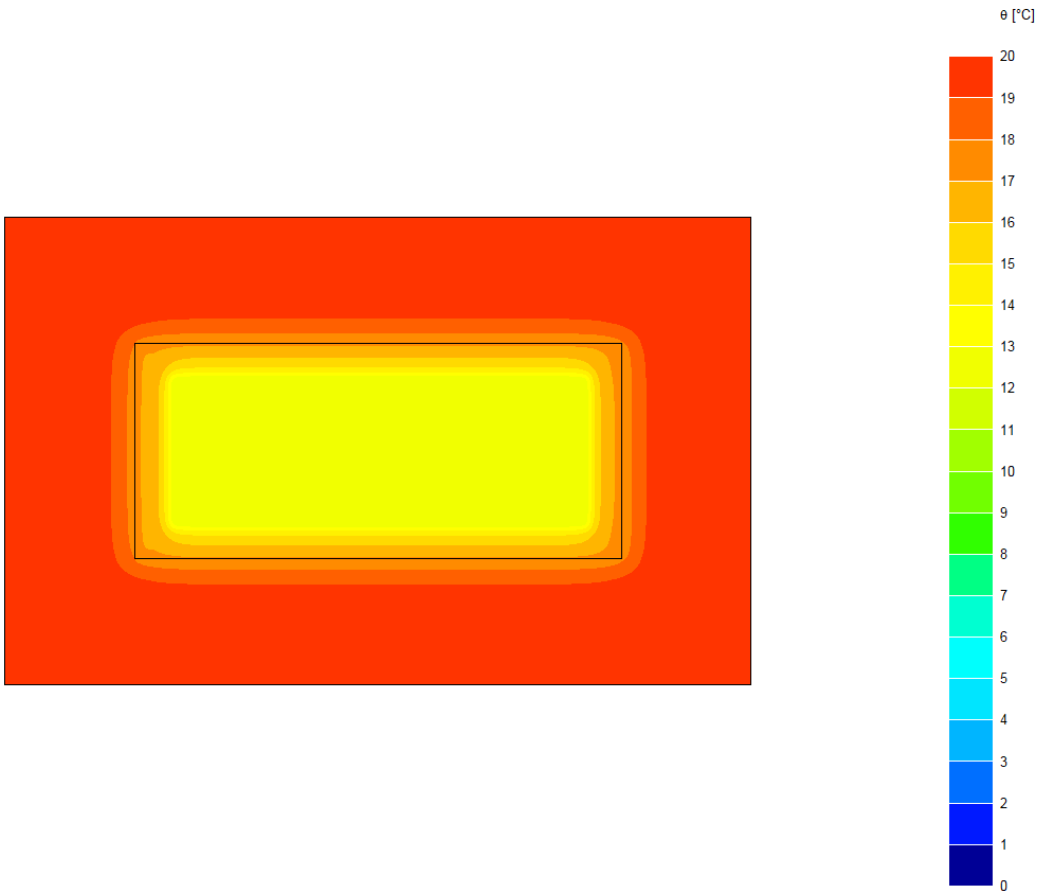

Figure 3 Isotherms including bracket (colour increment of 1°C, line increment of 5°C).

4.1.2 Point Thermal Bridge (χ-value):

Thermal Point Summary				
STIRA Standard Loft Ladder System				
Q	47.416		U	0.141
Ti	20		A	2
Te	0		X	2.0888
L^{3D}	2.3708			

$$L^{3D} = \frac{Q}{T_i - T_e} \quad (W/K) \qquad (9)$$

where:

Q = total heat flow from the internal to the external environment (W)

T_i and T_e = temperatures of the internal and external environments (°C).

$$\chi = L^{3D} - \sum (U \times A) - \sum \Psi \times \ell \quad (W/K) \qquad (10)$$

where:

L^{3D} = thermal coupling coefficient
U = U-value (W/m^2K) of the flanking element
A = area (m^2) over which U applies
Ψ = linear thermal transmittance of the linear thermal bridge
ℓ = length (m) over which Ψ applies.

4.2 U-value calculation

U-value calculation
by BRE U-value Calculator version 2.04g

Element type: Roof - Pitched roof - insulated ceiling
Calculation Method: I.S. EN ISO 6946

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.100		Rsi
1	12.5	0.210			0.060		Plasterboard
2	150	0.044	0.130	0.0900	3.409	1.154	Mineral wool quilt
3	150	0.044			3.409		Mineral wool
4		R-value[1]			0.200		Roof space
					0.040		Rse
	313 mm				7.218		

[1]Roof space - tiled roof, with felt or sarking boards

Total resistance: Upper limit: 6.934 Lower limit: 6.708 Ratio: 1.034 Average: 6.821 m²K/W

U-value (uncorrected) 0.147

U-value corrections

Air gaps in layer 2	ΔU = 0.000	(Level 0)
Discrete brackets:	ΔU = 0.025	(0.01 per m², χ = 2.089)

Total ΔU 0.025 (17.2% of U)

U-value (corrected) 0.172
U-value (rounded) 0.17 W/m²K

4.3 Trisco results

4.3.1 Graphics:

Figure 4 Material geometry.

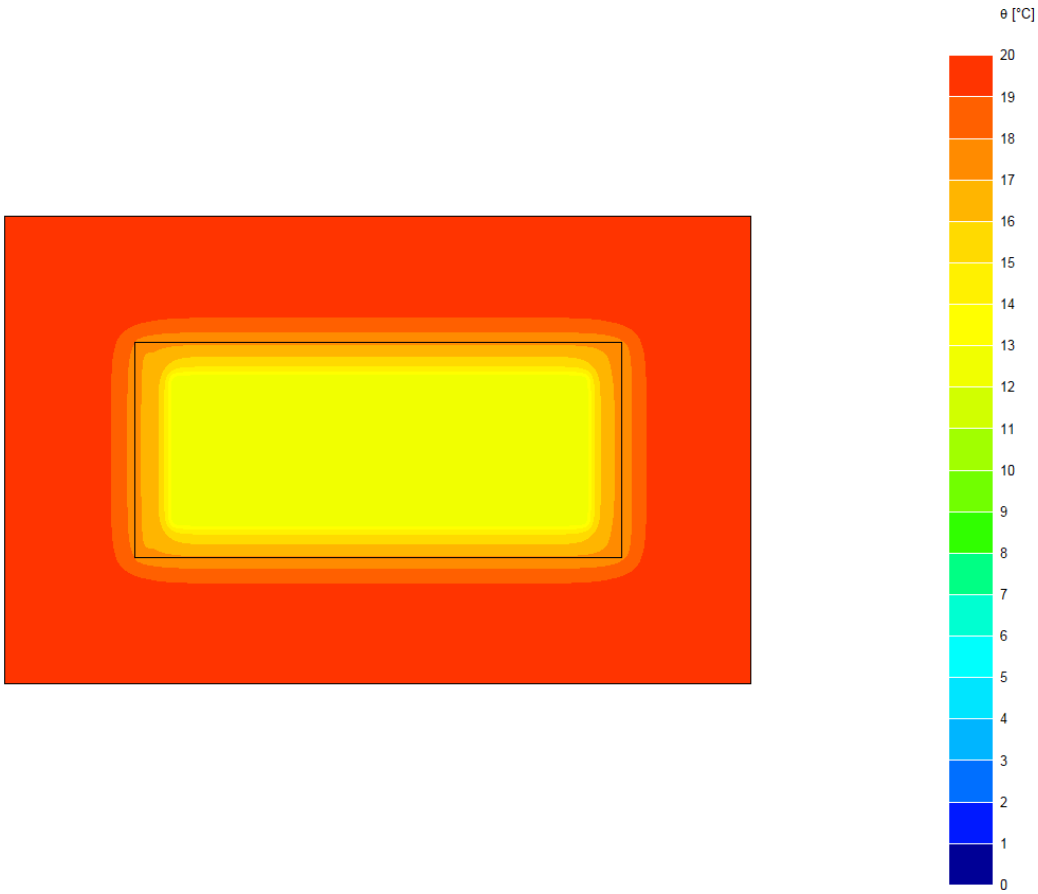

Figure 5 Isotherms (colour increment of 1°C, line increment of 5°C).

4.3.2 Trisco Data Summary:

TRISCO data file stira 02.trc
Number of nodes **2190726**

Material properties table:

Col.	Name	lambda [W/mK]	eps [-]
15	softwood	0.130	
30	softwood	0.130	
61	EPDM	0.250	
103	polyurethane_(PU)_foam	0.050	
124	plywood_500_kg/m3	0.130	
131	Mineral_Wool_	0.044	
161	gypsum_plasterboard	0.250	
192	cavity_non-vent_horizonta	0.056	
193	cavity_non-vent_horizonta	0.242	
195	cavity_non-vent_horizonta	0.059	
196	cavity_non-vent_horizonta	0.266	
197	cavity_non-vent_horizonta	0.059	
198	cavity_non-vent_horizonta	0.071	

Boundary condition table:

Col.	Name	t [°C]	h [W/m²K]	q [W/m²]	ta [°C]	tr [°C]	hc [W/m²K]	Pc [W]
171	External_(Sheltered)	0.0	10.00	0				
172	External_(Sheltered)	0.0	7.70	0				
182	Internal_(Up)	20.0	10.00	0				

4.3.3 FULL TRISCO RESULTS

TRISCO - Calculation Results

TRISCO data file: stira 02.trc

Number of nodes = 2190726
Heat flow divergence for total object = 0.000249865 %
Heat flow divergence for worst node = 0.0267754 %

2D/3D surplus thermal transmittance
dL = Q/(ti-te) - U1*A1 = 2.087 W/K
Equivalent thermal transmittance
Ueq = Q/((ti-te)*A1) = 1.184 W/(m².K)
  Q = 47.416 W
  ti = 20.0000°C
  te = 0.0000°C
  U1 = 0.141 W/(m².K)
       Xmin=1 Xmax=98 Ymin=0 Ymax=0 Zmin=0 Zmax=0
  A1 = 2.00256 m²
       Xmin=1 Xmax=1 Ymin=0 Ymax=195 Zmin=0 Zmax=140

Col.	Type	Name	tmin [°C]	X	Y	Z	tmax [°C]	X	Y	Z
15	MATERIAL	softwood	0.3739	77	69	42	18.4554	9	182	127
30	MATERIAL	softwood	0.6291	62	82	43	16.5069	8	38	104
61	MATERIAL	EPDM	7.9950	8	63	66	17.3458	7	23	117
103	MATERIAL	polyurethane_(PU)_foam	13.7840	14	144	24	17.2486	8	23	117
124	MATERIAL	plywood_500_kg/m3	8.3148	7	63	66	18.0123	1	143	113
131	MATERIAL	Mineral_Wool_	0.0081	98	69	13	19.5568	18	195	0
161	MATERIAL	gypsum_plasterboard	15.4573	16	144	23	19.7049	1	194	1
171	BC_SIMPL	External_(Sheltered)	0.0081	98	69	13	10.6241	8	82	81
172	BC_SIMPL	External_(Sheltered)	0.0081	98	69	13	16.0811	13	141	117
182	BC_SIMPL	Internal_(Up)	12.0049	1	63	66	19.7049	1	194	1
192	EQUIMAT	cavity_non-vent_horizonta	11.9072	43	130	69	17.3507	16	128	127
193	EQUIMAT	cavity_non-vent_horizonta	4.0640	62	123	44	16.6767	8	133	104
195	EQUIMAT	cavity_non-vent_horizonta	14.8878	9	68	104	16.7982	8	33	106
196	EQUIMAT	cavity_non-vent_horizonta	4.1622	62	38	44	16.6628	8	33	104
197	EQUIMAT	cavity_non-vent_horizonta	14.8648	9	68	36	16.7972	8	33	34
198	EQUIMAT	cavity_non-vent_horizonta	13.1789	42	170	69	18.2617	9	174	127

Col.	Type	Name	ta [°C]	Flow in [W]	Flow out [W]
171	BC_SIMPL	External_(Sheltered)		0.0000	38.7375
172	BC_SIMPL	External_(Sheltered)		0.0000	8.6780
182	BC_SIMPL	Internal_(Up)		47.4167	0.0000