[redacted] Consultants

Assessment of Roof Renovation after Discovery of Fault in Askeaton, Co Limerick

Report commissioned by Mr and Mrs Black

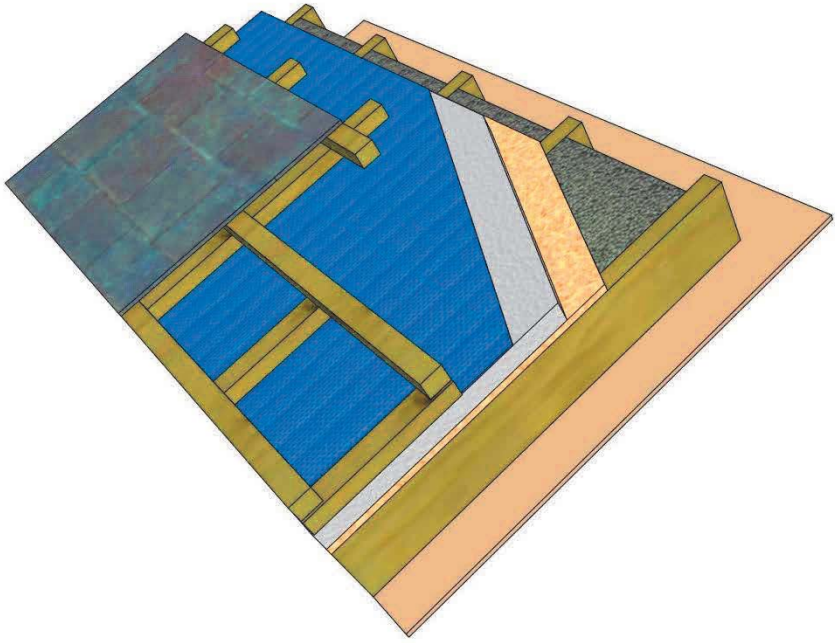


Figure 1: Sketch detail of Roof Assembly

REFERENCE
290518

DATE:
29th May 2018

Authour - [redacted]

Group Technical Manager BTech, MEngSc,MIEI, CEPHC

[redacted] Consultants,
Main Street, [redacted], Co.Meath

Tel: [redacted]

[redacted]onsultants.com

Contents

1. Aim of Report

A builder completed a deep renovation of an old farmhouse owned by Mr and Mrs Black 3 years ago. The project features a newly constructed cathedral ceiling with EPS insulation between the rafters, and an OSB3 racking board and EPS insulation above the rafters (see figure 1).

It has recently been established that the racking board has become rotten, though it is unclear if the moisture damage is occurring locally or throughout. The cause is unknown. It is also unknown if the rafters are affected. Mr and Mrs Black have retained [redacted] Consultants to carry out a desktop assessment and provide a report on the most likely cause(s) of failure, before any opening-up works are done.

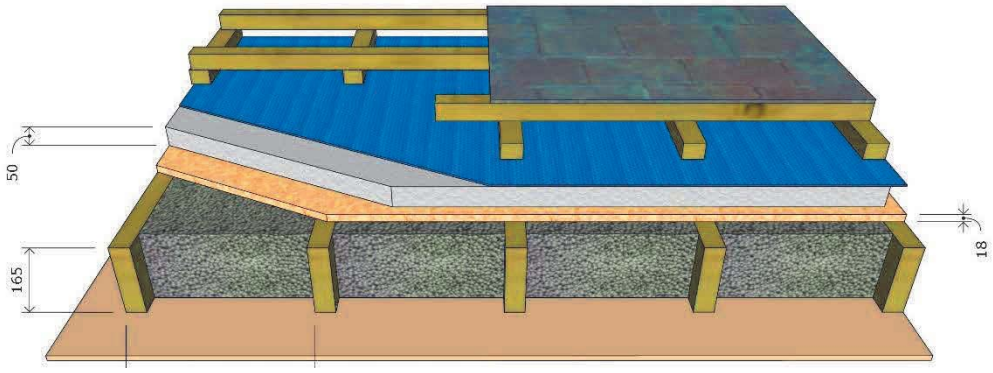


Figure 2: Sketch detail of Roof Assembly

From outside to inside the roof build-up is (see figure 2):

- slates on timber counter battens on SOLITEX PLUS sarking felt,
- on 50mm white ACME EPS 100 insulation,
- on taped 18mm OSB-3 board and airtightness layer,
- on 165mm rafters with 165mm ACME EPS Silver 70 between,
- on 12.5mm plasterboard finished internally.

Front and rear of house face north-south. Roof is at 35 degree pitch. Rafters are 48mm wide at 600mm centres.

The aim of this assessment is to present the outcome of a hygrothermal risk analysis, assessing existing roof assembly (see Figure 2) for the potential risk of interstitial condensation, mould and degradation of the OSB3 board and the potential risk to timber members.

Damage in the roof may be due to one or a contribution of factors such as:

- A leak in the roof
- Poor construction practices
- The performance characteristic of the materials used
- Implications of the internal or external boundary conditions

In order to assess the implications of these factors outlined above and based on the form of construction, **only** a desktop hygrothermal risk evaluation using WUFI

(https://wufi.de/en/software/wufi-pro/) or Delphin (http://bauklimatik-dresden.de/delphin/index.php?aLa=en) numerical software (under IS EN 15026) should be used.

A conventional "Dew point analysis" using Glaser Method software (under IS EN ISO 13788) such as BuildDesk U (http://www.builddesk.co.uk/software/builddesk-u/) or JPA (http://www.techlit.co.uk/software/Uvalue.htm) are not suitable for such as assessment as this standard does not account for critical aspects of the assessment (limited climate data, hygrothermal functionality, etc).

2. Methodology

Numerical Hygrothermal analysis has been carried out using WUFI PRO 6.1 in accordance with IS EN 15026.

WUFI from the Fraunhofer Institute for Building Physics is a leading software for hygrothermal numerical simulation too which is fully validated under I.S. EN 15026:2007, the relevant standard. It deals with the inter-related effects of heat, liquid water and water vapour moving through components over any length of time, on an hourly basis (usually), where boundary conditions (such as external weather) vary. It can be used to assess risk of interstitial condensation, mould risk, freeze-thaw events and transient thermal performance over the specified period (as opposed to a steady-state U-value) among other uses.

Unlike the more commonly used Glaser method, transient hygrothermal simulation is suitable for use with hygroscopic, capillary active and porous building materials:
"While the Glaser method considers only steady-state conduction of heat and vapour diffusion, the transient models covered in this standard take account of heat and moisture storage, latent heat effects, and liquid and convective transport under realistic boundary and initial conditions. The application of such models has become widely used in building practice in recent years, resulting in a significant improvement in the accuracy and reproducibility of hygrothermal simulation." Introduction, I.S. EN 15026:2007

3. Numerical Models

The hygrothermal models depict roof assemblies as designed, based on information received from our client. These are shown in Figure 3 below:

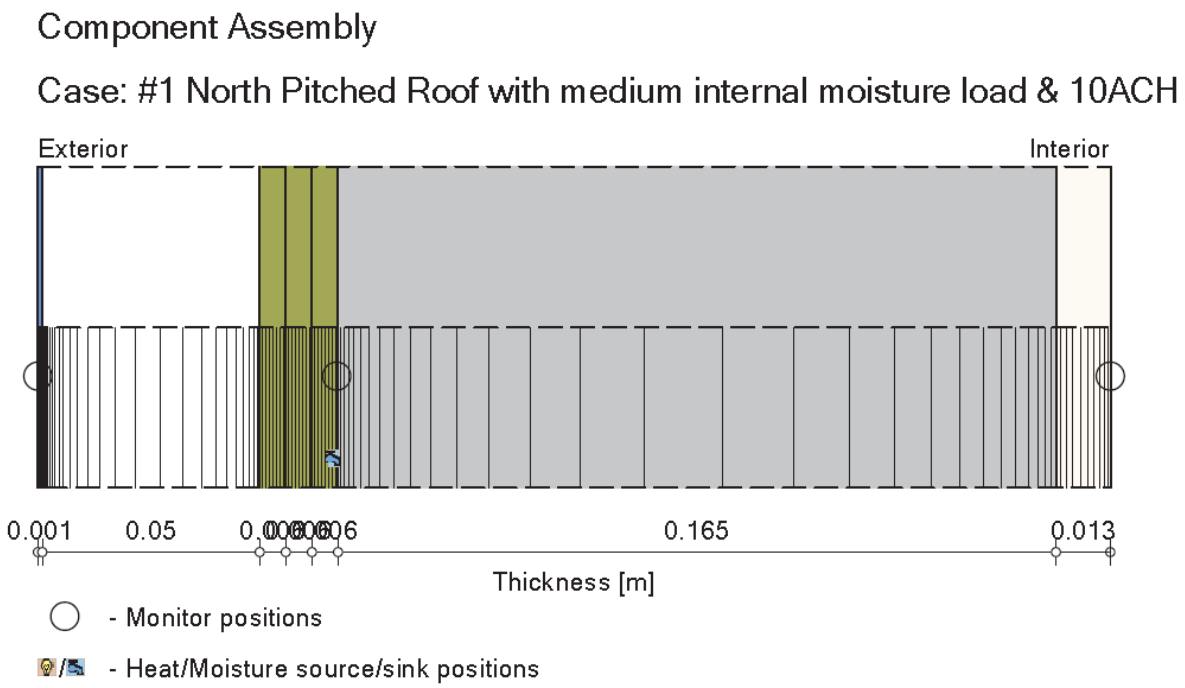


Figure 3: Numerical Model for Roof

Simulation settings

The following are primary factors accounted for when setting up the WUFI models. It was considered that the simulation would be limited to a 3-year period to reflect the period of time since construction was completed.

Internal climate

The internal climate is based on 2 scenarios:

1. A normal moisture load with sufficient ventilation, and it has been calculated based on the external climate data (following the procedure in Annex C of BS EN 15026:2007). A normal moisture load for this climate roughly corresponds to internal RH values of 30 – 60%.
2. A high internal moisture load with inadequate ventilation, and it has been calculated based on the external climate data (following the procedure in Annex C of BS EN 15026:2007). A high internal moisture load for this climate roughly corresponds to internal RH values of 40 – 70%.

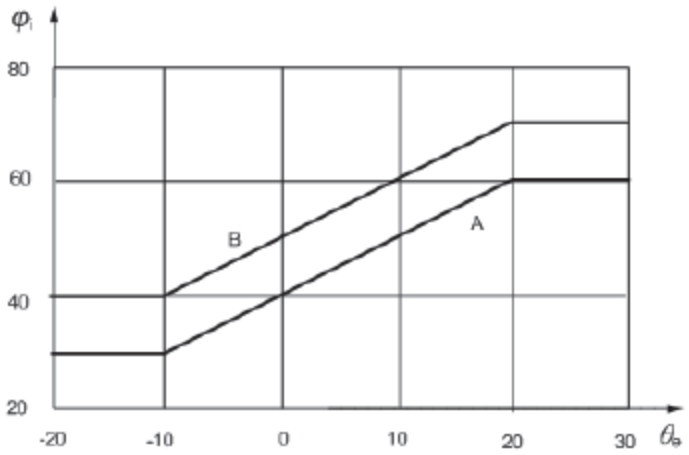


Figure 4: Daily mean humidity in buildings for medium and high occupancy as per Annex C of BS EN 15026:2007

Table 1 provides a summary of material properties used in the WUFI calculations (see appendix A for further details).

Material	Thickness mm	Thermal conductivity W/m.K	Water Vapour diffusion resistance factor μ	SHC (J/KgK)	Bulk Density Kg/m^3	Porosity	Source
Solitex Plus	1 mm	0.17	72	1000	275	0.001	supplied by pro clima
ACME WHITE EPS 100	50 mm	0.036	30 (mean of 20-40)	1500	15	0.95	A combination of *IBP library - 15 kg/m^3 and the manufacturer ACME NSAI certification data
Smartply OSB 3	18 mm	0.11	(mean of 170-240)	1400	615	0.9	Based on a combination of OSB **615kg/m^{3}from the IBP library and the DOP from Smartply Split into three 6mm layers
ACME EPS Silver 70	165mm	0.031	50 (mean of 30-70)	1500	15	0.95	A combination of IBP library - 15 kg/m^3 and the manufacturer ACME NSAI certification data
Gypsum board	12.5mm	0.2	8.3	850	850	0.65	IBP library

Table 1 – Characteristic values of materials used in simulation (see appendix A for further details)
*IBP – refers to Institute for Building Physics
**Consultation with a technician in IBP recommended that for highest accuracy use OSB3 615kg/m3 as the base file

To assess the potential cause of damage 7 different scenarios were modelled in WUFI 1D. Key parameters which were assessed were:

- Influence of roof orientation (South or North) and increased risks associated with this
- Influence of variation of internal relative humidity depending on ventilation strategy and effectiveness
- A high initial moisture content of OSB3 due to exposure to the elements at the building phase prior to the external thermal insulation and SOLITEX PLUS been applied.
- A scenario where the SOLITEX PLUS/roof covering has been damaged and the resultant moisture ingress over the 3-year calculation

The seven cases are described as follows:

1. North Pitched Roof with medium internal moisture load & air leakage source of 10ACH
2. South Pitched Roof with medium internal moisture load & air leakage source of 10ACH
3. North Pitched Roof with high moisture load & air leakage source of 10ACH
4. South Pitched Roof with high internal moisture load & air leakage source of 10ACH
5. South Pitched Roof, **leaking SOLITEX**, Medium moisture load & air leakage source of 10ACH
6. North Pitched Roof , medium moisture load , air leakage source of 10ACH, **WET OSB**
7. North Pitched Roof , high moisture load , air leakage source of 10ACH, **WET OSB**

Calculation Quality:

To assess the quality of each calculation the author reviewed the balance and no of convergence failures with in the simulations (see appendix C). A quality/accurate assessment will have similar moisture balance figures and a very low number of convergence failures. The total number of convergence failures is a first hint concerning the reliability of the results. A low number of convergence failures and excellent Balance was recorded in all calculations (see sample below).

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 12:24:45
Computing Time	1 min,35 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	1

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -0.55
Integral of fluxes, right side (kr,dr)	[kg/m²]	4.2E-8 -0.06
Balance 1	[kg/m²]	-0.45
Balance 2	[kg/m²]	-0.48

4. Input Data and Assumptions

The following assumptions have been made:

- The OSB3 has been identified as the airtightness and vapour control layer. Therefore, it can be assumed that service penetrations, joints and junctions to adjacent building elements, of the gypsum plasterboard are not sealed airtightly. As an assumption, an air permeability of q50 = 10 m^3/m^2h has been assumed, leading to the corresponding amount of potential condensation (from air leakage through internal plasterboard) at the inner face of the OSB3 sarking board.
- The critical component within this assembly is the OSB3 layer in particular the inne 6mm portion. In order to monitor the hygrothermal behaviour of this element as accurately as possible it has been spilt into 3 6mm pieces.
- Material data for the OSB3 has been created based on a combination of material data from IBP Fraunhofer and a locally produced OSB3 board (see appendix A)
- External climate has been supplied by an external expert, from data for Shannon airport, the closest available weather file.
- Internal climate is based on 2 cases, a normal moisture load as per I.S. EN 15026 (RH values between 30 and 60%) and a high moisture load (RH values between 40 and 70%) for purpose of investigation.
- In the majority of cases, simulations start at 1st October with all materials at 80% RH, except cases 6 and 7 where an initially WET OSB3 board is modelled (i.e. presenting a case where materials may have become wet on site). This is to assess the drying potential (stress test) for the roof structure in the event that materials have become wet at the building phase or over the lifetime of the building due to an unforeseen event. In the authors experience it is not unusual to measure moisture contents in excess of 30% within OSB on site (see image 1). Therefore, in these cases an initial moisture content of 30% was used.

Image 1: A moisture meter reading on site inspection reading a moisture content >30% in OSB3.

- Case 5 models the roof in the event of a leak occurring through the roof covering (i.e. failed flashing or slate) and SOLITEX PLUS.
  This is to stress test the roof structure should such an event occur. A moisture source of 1% was included for such a scenario on the outter 2mm of the exterior 6mm section of OSB3 (see Figure 5). This was deemed adequate, especially given the vicinity of the roof to the Irelands south west prevailing wind driven rain (also following consultation with the manufacturer of the roofing membrane), and a South orientation for this case which meet the prevailing wind driven rain. The location of the building is classified as Very Severe in accordance with BR 262.
  To represent the leak a moisture source has been included as noted on figure 5.

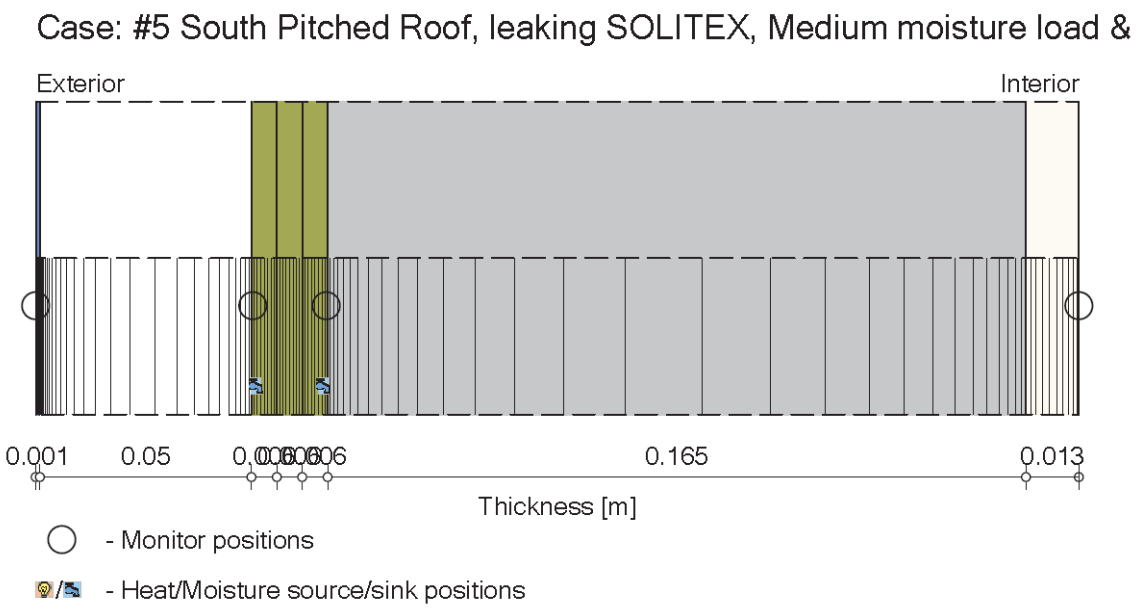


Figure 5: Numerical model for roof with leaking SOLITEX PLUS, note the additional moisture source on the outside of the outer layer of OSB3.

- All input data, including material properties, boundary conditions, and surface transfer coefficients, is included in the WUFI reports in Appendix C.
- No shading is accounted for due to adjacent buildings or foliage. Shading will greatly reduce the drying potential of the roof structure if this is present on site.

Limitations of Hygrothermal Assessment:

- **Material Input Data:**
  While WUFI contains a broad array of construction materials, these may have different characteristics to those used on site (see source of material data in Appendix A). Until the construction is opened up and inspected, the author has assumed the source of materials used on site (see appendix A).
- **Limitations of the Mathematical Model:**
  WUFI Pro 6.1 only deals with one dimensional movement of heat, water and humidity. Items such as geometric thermal bridges or 2 dimensional movement of heat, moisture and humidity can only be modelled with WUFI 2D. [redacted] Consultants do not have access to this software.
  To model junctions from wall to roof or where timber rafters meet OSB a specialist must be employed to carry out such assessments. Contact details for such a specialist are available on request.
  This report is limited to one dimensional hygrothermal assessments.

- **Initial Conditions:**
  The initial conditions at the time of construction for the building is unknown (i.e. whether materials were installed dry or wet at the time of building). Cases have been modelled to assess the drying potential for the roof structure in the event that materials have become wet at the building phase or over the lifetime of the building.
- **Internal Conditions:**
  There is no information provided in relation to humidity levels or the ventilation method for the living space. The assessment will assess the impact of a range internal humidity's, Medium and High.

- **External Climate Conditions:**
  The weather file provided is for Shannon. While this is nearby there may be some slight discrepancies in the weather file compared to specific conditions on site. There is also limited data in relation to adjacent buildings and foliage and the impact this may have on exposure to short and long wave radiation.

5. Results and Analysis

In summary the results of the hygrothermal assessment are given in table 2 below:

Case	Orientation	Internal Climate Moisture Level	Leaking SOLITEX PLUS?	Wet OSB3	% RH At Inner OSB3 Exceeds 80%?	Moisture Content of inner OSB 3 Exceeds 20%?	Mould Risk	Acceptable?	Notes
1	North	Medium	No	No	No	No	No	Yes	
2	South	Medium	No	No	No	No	No	Yes	
3	North	High	No	No	Yes	No	Yes	No	RH > 80% for prolonged periods increasing mould risk
4	South	High	No	No	Yes	No	Borderline	No	RH > 80% for shorter periods, but at regular intervals
5	South	Medium	Yes	No	Yes	Yes	Yes	No	Destructive failure
6	North	Medium	No	Yes	Yes	Yes	Yes	No	
7	North	High	No	Yes	Yes	Yes	Yes	No	High risk of failure

Table 2: Summary of results from hygrothermal assessment of each case

Figures 7 and 8 on the following pages provide a graphical representation of the cases outlined on table 2 above. These figures provide a clear representation of 2 key parameters required to assess the risk of mould and damage to the racking board, these are the moisture content and relative humidity at the inner OSB3 layer.

Growth of mould fungi and the time needed for the initiation of mould growth is mainly regulated by water activity, temperature, exposure time, and surface quality of the substrate. (Viitanen et al 2007). It is widely accepted that in order to reduce the risk of mould growth on timber elements the relative humidity must not exceed 80% for prolonged periods.

A biohygrothermal model has been developed to assess mould growth under transient hygrothermal boundary conditions. This post processor tool is called WUFI BIO (https://wufi.de/en/2017/03/31/wufi-bio/)

The author carried out an assessment of the roof assembly using WUFI BIO to assess the risk of mould growth in each scenario which provided input to table 2.

Figure 6 presents a sample outputted analysis using WUFI BIO. Case 3 is presented in this case. A **signal light** in the top left corner summarises the mould growth risk indicated by WUFI-Bio in a simple 'yes/maybe/no' acceptability scheme. Red indicates excessive mould growth (>200mm per year), amber indicates mould growth between 50-200mm, which may be acceptable with additional investigation. Green indicates mould growth less than 50mm per year which is usually acceptable.

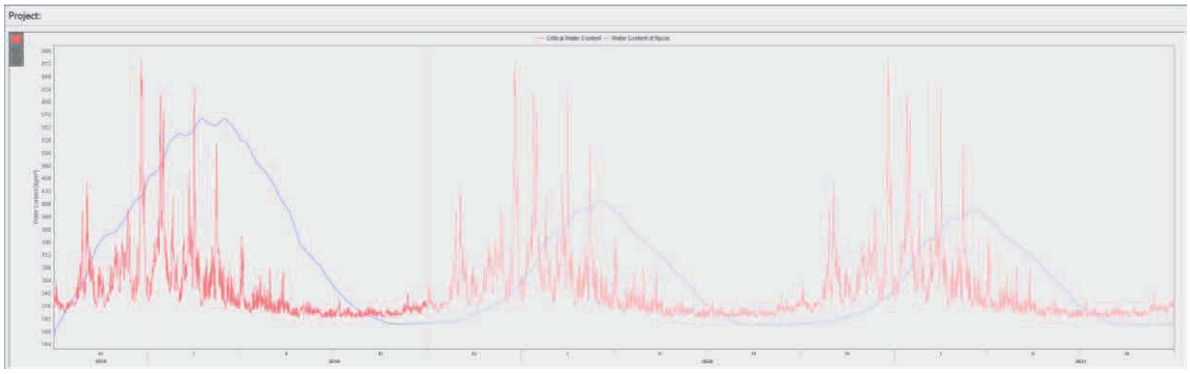


Figure 6: WUFI BIO result. In Case 3 the risk of mould is very high (high internal moisture load). **Note the red light**

Figure 7 below provides a comparison of the relative humidity at the inner 6mm layer of OSB3 adjacent to the ACME EPS Silver 70 . When assessing the risk of mould growth at timber elements and derived timber sheathing, a relative humidity in excess of 80%, highlighted by the bold line in this graph, is considered as a risk threshold.

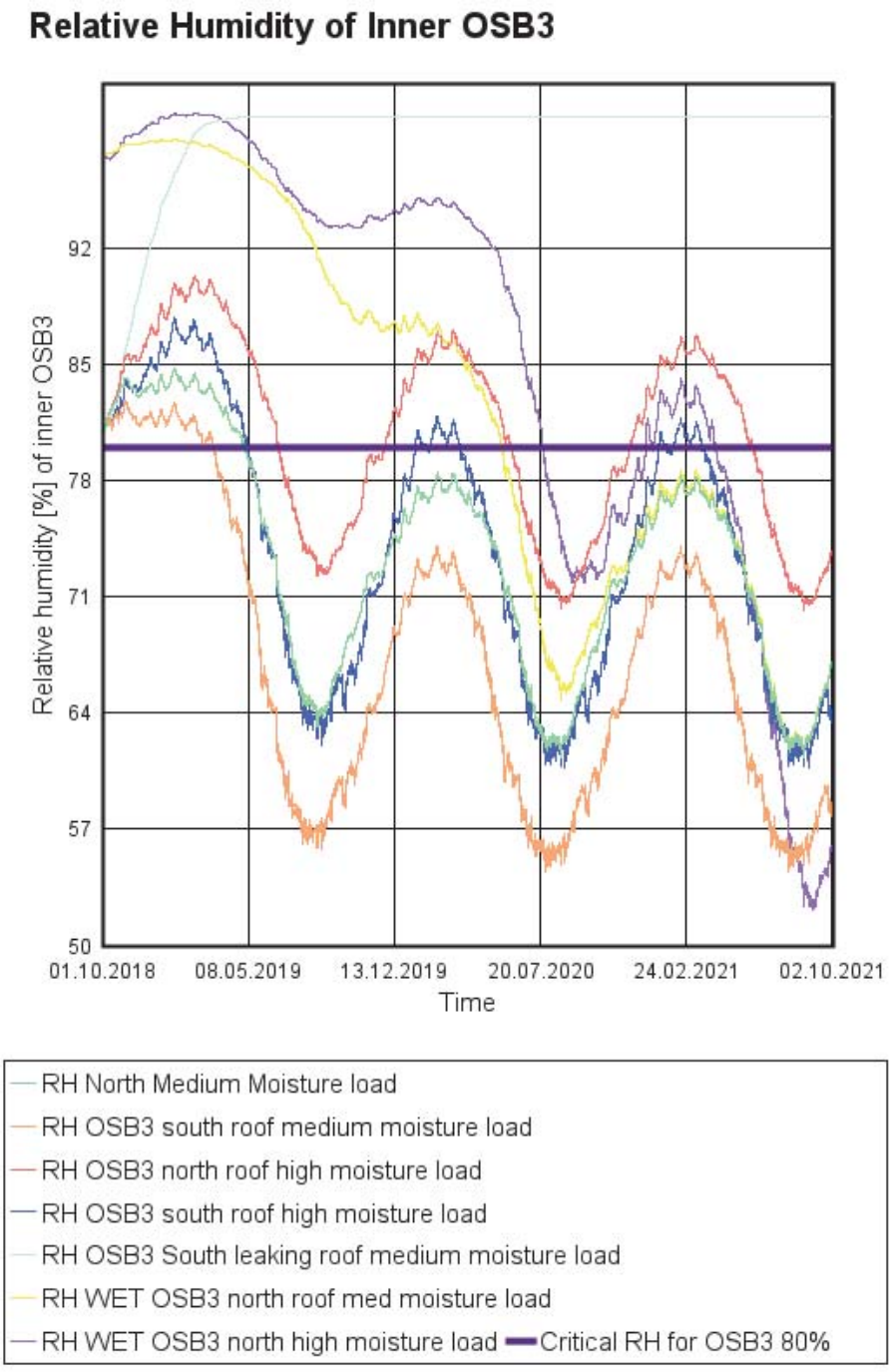


Figure 7: A comparison of the relative humidity at the inner layer of 6mm layer of OSB3 adjacent to the ACME EPS Silver 70 . When assessing the risk of mould growth at timber elements and derived timber sheathing, a relative humidity in excess of 80%, highlighted by the bold line in this graph, is considered as a risk threshold.

COMMENT:

While all cases initially present a relative humidity in excess of 80% initially, this is to be expected as the moisture content of all OSB3 boards (with the exception of the intentionally wet OSB 3) and materials at beginning of the calculation is measured at an initial humidity of 80% (as per IS EN 15026).

After beginning initially above 80% RH, on case's 1 and 2 reduce to < 80%.

Case 4 can be categorised as borderline mould risk as it only marginally exceeds an RH of 80% for 2 months in January and February each year. On the other hand, Case 3 exceeds 80% for longer periods as this is on a North orientation whereas Case 4 is on a southerly orientation. As a result, the risk of mould is much higher.

Cases 6 and 7 represent scenarios where the OSB3 has become wet at the building phase. In both cases mould growth is almost certain, in particular on a Northern Orientation with a high moisture load. Moisture ingress may have occurred prior to the external roof covering been applied. This also often occurs when screeds, and plasters are being applied inside. In the absence of a sealed vapour control layer between the plasterboard and insulation, and adequately ventilation, vapour can rapidly bypass gaps in the EPS and accumulate at the OSB3 layer. The author has observed this on site as per image 2 below.

Image 2: moisture accumulation behind sarking board and resultant mould following wet trades

It can be noted that as a general rule, North orientations present the high relative humidity's and therefore high mould risk. This is due to the reduced drying capacity and cooler temperatures on this orientation.

Case 5 classified as the "leaking roof" presents a scenario where the SOLITEX PLUS membrane and roof covering has been damaged leading to liquid water ingress. This leads to destructive failure over a very short period as the construction does not have the drying capacity to cope with this major unforeseen moisture load. RH never drops below 80%.

Figure 8 presents a comparison of the water content of the inner 6mm layer of OSB3 adjacent to the ACME EPS Silver 70 . When assessing the risk of rot and decay of timber elements and derived timber sheathing such as OSB3, a a moisture content in excess of 20%, highlighted by the bold line in this graph, is considered as a risk threshold.

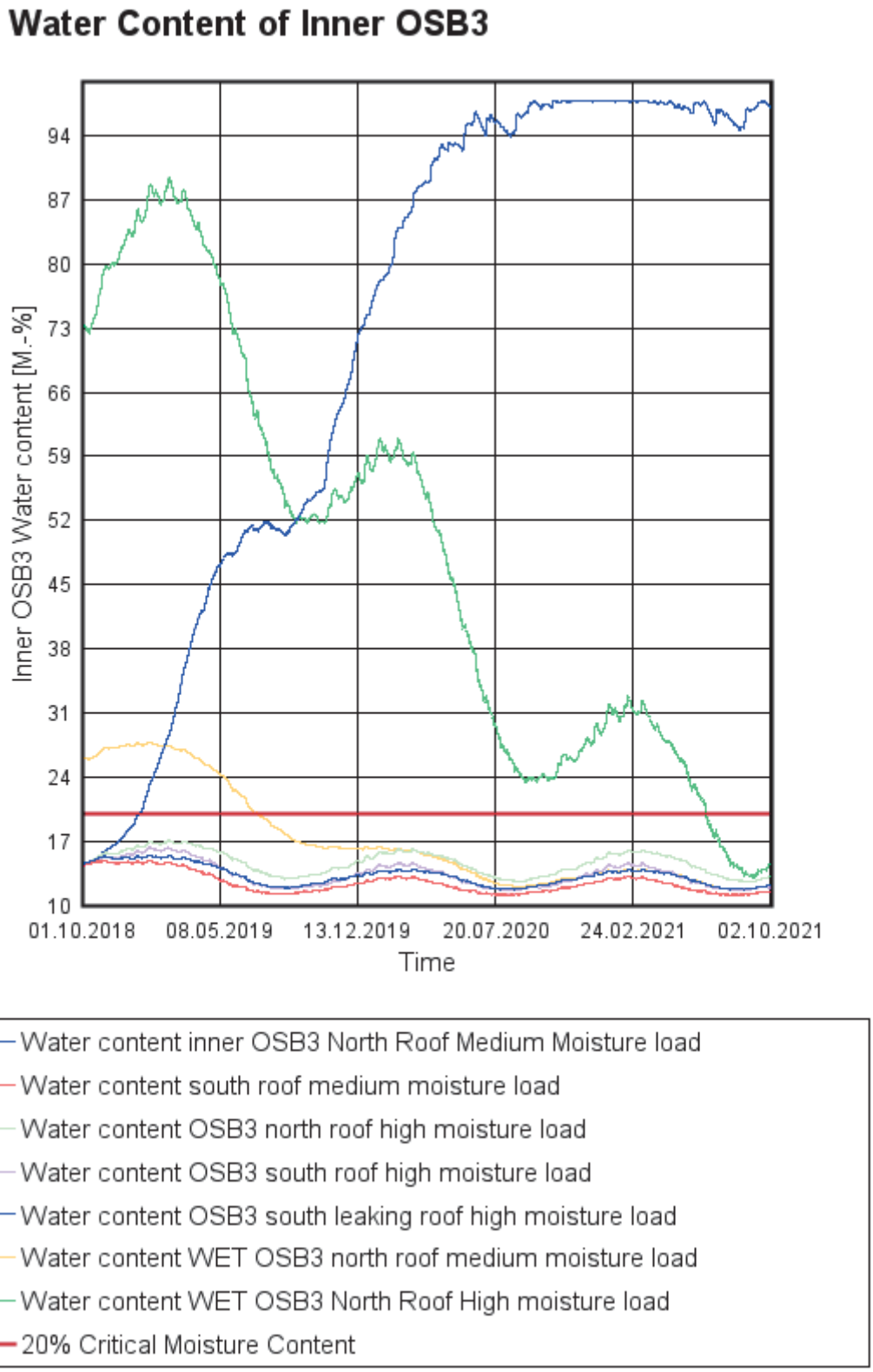


Figure 8: A comparison of the water content of the inner 6mm layer of OSB3. Note When assessing the risk of rot in timber elements, **20 mass-percent** moisture content (highlighted by the bold line on this graph, is considered as a risk threshold.

COMMENT:

While all cases initially present an initially higher moisture content, this is to be expected as the moisture content of all OSB3 boards (with the exception of the intentionally wet OSB 3) and materials at beginning of the calculation is measured at an initial humidity of 80% (as per IS EN 15026).

In cases 1-4 the moisture content of the OSB3 never exceeds 20%i indicating the risk of timber decay and rot is low.

Cases 6 and 7 represent scenarios where the OSB3 has become wet at the building phase. In both cases the moisture content exceeds 20%. On a Northern Orientation with a high moisture load there is a much higher risk of rot and decay of the OSB3 due to the high internal moisture load.

In the event that the internal moisture load is lower (medium moisture load Case 6), the risk of rot and decay is significantly less.

Case 5 classified as the "leaking roof" presents a scenario where the SOLITEX PLUS membrane and roof covering has been damaged leading to liquid water ingress. This leads to destructive failure over a very short period as the construction does not have the drying capacity to cope with this major unforeseen moisture load. The moisture content reaches super saturation in less than 2 years.

6. Conclusions

The outputs from hygrothermal simulations show that the performance of the roof assembly is within acceptable tolerances if built as designed in dry conditions. Even in the presence of air leakage, the resulting amounts of condensate are small and do not accumulate annually.

If the OSB3 boards in the roof are found to have rotted, it is the authors opinion that the cause of degradation is likely to be a source of liquid moisture, such as:

1) A leak in the SOLITEX PLUS membrane that is feeding moisture into the assembly regularly. No roof assembly can deal with a frequent moisture source; or
2) Alternatively, a very high initial moisture content in the installed OSB3 due to lack of care in storing materials on site and/or installing in wet weather. The strategy of applying an airtight external OSB3 sarking on the outside of the roof may impede the ability for site moisture to dry out leading to a particularly high risk of moisture accumulation at the building phase within the OSB3 layer. In the absence of a sealed airtightness and vapour control layer on the inside, site moisture can readily bypass the EPS and accumulate on the inside of the OSB3.
A roof of the kind shown may not have the drying capacity to compensate for poor site practice of this kind.

Specific Comments:

It would be the authors opinion that a more robust strategy would be to include a sealed humidity variable vapour control layer such as INTELLO PLUS, on the warm side of the thermal insulation, prior to the plasterboard been applied. This will protect the structure from site moisture during the building phase and reduces the risk of air infiltrating to the OSB3 board when internal humidity may be high.
It is unusual to apply the airtightness layer (OSB3 in this case) towards the outside of the thermal insulation layer. As a rule of thumb, no more than a 3rd of the thermal resistance should reside on the inside of the airtightness and vapour control layer.

Disclaimer,

This report is the copyright of [redacted] Consultants and has been licensed to for their use only. If a third party wishes to use the report they should contact [redacted] Consultants directly.
We ([redacted] Consultants) make our best efforts to provide accurate and authoritative information in regard to the subject matter covered. As clarified in the report above and Caveat and Context below, the area of hygrothermal risk assessment and proper measurement of all hygrothermal characteristics of Building materials are emerging, but separate and related, disciplines. Assessments are therefore undertaken in a context of large areas of uncertainty, namely material properties, climate (macro and micro, external and internal) care of construction and Building usage.
Our methodology is designed to deal with, and limit, uncertainty by use of varying characteristics and bracketing values. However we make no warranty of any kind, expressed or implied, with regard to the accuracy of the resulting information. The information must be used with care, by professionals who understand the implications of what they are doing. We shall not be liable in the event of incidental or consequential damages in connection with, or arising from, the use of the information.

Caveat and Context,

This simulation was carried out with WUFI Pro 6.1, one-dimensional hygrothermal simulation software developed by the Fraunhofer Institute of Building Physics in Germany under BS EN 15026. As it deals with one-dimensional geometries it is not ideal for bridged structures, however if used correctly it can usually give useful guidance for these structures.
Most of the data available within the WUFI Pro materials database are physically tested and analysed by the Fraunhofer IBP or sister Building physics institutes in various parts of Europe and America. There are only a few building materials used in the UK & Ireland that are listed within this growing database. When client-selected materials appear different to their equivalent within the WUFI Pro materials database, this assessor selects the nearest material and changes it based on the values supplied by the manufacturer.
The materials used in the simulation presented in this report are as close as we can obtain to the real materials under investigation. Given the above context, while we go to a lot of effort to be as accurate as possible, it is likely the data will differ (between actual and simulated values) for at least some areas of the simulated build-up. In many cases this will not be significant enough to skew the assessment of how suitable a build-up is, but in other cases (such as foils) it can have a big impact. We have found that often ‘external’ issues such as the extent of driving rain, the water absorbing characteristics of the outer surface, the moisture load of the enclosed room, the U-value and the original substrate (in refurbishment or internal insulation projects) have a greater impact of the simulated build-up than the materials themselves. Where external conditions are so great as to cause building failure for one insulation system alternatives may be close behind. The message is that we have to think very clearly of the context in that the build-up in question will be located and used

Appendices

Appendix A: Source Materials

List of Materials used in assessment:

Pro clima SOLITEX PLUS vapour permeable roofing underlay

Manufacturers WUFI material data provided from pro clima GERMANY

ACME EPS 100 White.

Primary WUFI material file based on EPS 15kg/m3 sourced from the Fraunhofer IBP material library. Thermal conductivity and vapour resistance factor (μ) sourced from high quality Irish manufactured EPS, ACME EPS 100 White. This material data sourced from this products NSAI certification below.

ACME EPS 100 White

Essential Characteristics	Performance	Test Standard	Harmonised Standard
Thermal Conductivity*	0.036W/mK	EN 12667	EN 13163:2012 + A2:2016
Reaction to Fire*	Class E	EN 15715	
Length*	L3	EN 822	
Width*	W3	EN 822	
Thickness*	T2	EN 823	
Compressive Strength*	CS(10)100	EN 826	
Bending Strength*	BS150	EN 12089	
Dimensional Stability*	DS(N)5	EN 1603	
Flatness*	P(5) ≤0.72m² P(15) >0.72m²	EN 825	
Squareness*	S(5)	EN 824	
Long Term Water Absorption by Partial Immersion*	WL(P)I 0.2kg/m²	EN 12087	
Long Term Water Absorption by Total Immersion*	WL(T)I 4.5%	EN 12087	
Long-Term Compressive Creep Behaviour	≤2%	EN 13163 Annex F	
Shear Behaviour	75kPa	EN 13163 Annex F	
Water Vapour Diffusion Factor	30 to 70	EN 13163 Annex F	

ACME EPS Silver 70

Primary WUFI material file based on EPS 15kg/m3 sourced from the Fraunhofer IBP material library. Thermal conductivity and vapour resistance factor (μ) sourced from high quality Irish manufactured EPS, ACME EPS SILVER 70. This material data sourced from this products NSAI certification below.

ACME EPS Silver 70

Essential Characteristics	Performance	Test Standard	Harmonised Standard
Thermal Conductivity*	0.031W/mK	EN 12667	EN 13163:2012 + A2:2016
Reaction to Fire*	Class E	EN 15715	
Length*	L3	EN 822	
Width*	W3	EN 822	
Thickness*	T2	EN 823	
Compressive Strength*	CS(10)70	EN 826	
Bending Strength*	BS100	EN 12089	
Dimensional Stability*	DS(N)5	EN 1603	
Flatness*	P(5) ≤0.72m² P(15) >0.72m²	EN 825	
Squareness*	S(5)	EN 824	
Long Term Water Absorption by Partial Immersion*	WL(P)I 0.2kg/m²	EN 12087	
Long Term Water Absorption by Total Immersion*	WL(T)I 5%	EN 12087	
Long-Term Compressive Creep Behaviour	≤2%	EN 13163 Annex F	
Shear Behaviour	50kPa	EN 13163 Annex F	
Water Vapour Diffusion Factor	20 to 40	EN 13163 Annex F	

Smartply OSB3

Primary WUFI material file based on OSB 615kg/m3 sourced from the Fraunhofer IBP material library. Based on consultation with representatives from IBP Fraunhofer this is the most reliable base file to utilise in such scenarios.

It is likely that if OSB3 is used, it will be a SMARTPLY board as this is the most widely used OSB3 board in Ireland.

Thermal conductivity and vapour resistance factor (μ) sourced from Irish manufactured Smartply OSB3. This material data sourced from this products DOP certification below.

SMARTPLY
DEFINING THE STANDARD OF OSB

DECLARATION OF PERFORMANCE

Reference number **DOP01REV3**

SMARTPLY,
Belview,
Slieverue,
Waterford,
Ireland.

Product Type	Intended Use	AVCP*	Notified Body Reference
OSB/3	Intended use as structural components in humid conditions	2+	0050

*Assessment and verification of constancy of performance system according to Annex V of regulation (EU) No 305/2011

Declared Performance

Essential Characteristics	Performance										Harmonised technical specification
Thickness Range (mm)	>6 to 10		>10 to 18		>18 to 25		>25 to 32		>32 to 40		
Angle to Major Axis	0	90	0	90	0	90	0	90	0	90	
Characteristic Strength (N/mm^2) - Bending f_m	18.0	9.0	16.4	8.2	14.8	7.4	NPD	NPD	NPD	NPD	
- Compression f_c	15.9	12.9	15.4	12.7	14.8	12.4	NPD	NPD	NPD	NPD	
- Tension f_t	9.9	7.2	9.4	7.0	9.0	6.8	NPD	NPD	NPD	NPD	
- Panel Shear f_v	6.8		6.8		6.8		NPD		NPD		
- Planar shear f_r	1.0		1.0		1.0		NPD		NPD		
Mean Stiffness (MOE) (N/mm^2) - Tension E_t	3800	3000	3800	3000	3800	3000	NPD	NPD	NPD	NPD	
- Compression E_c	3800	3000	3800	3000	3800	3000	NPD	NPD	NPD	NPD	
- Bending E_m	4930	1980	4930	1980	4930	1980	NPD	NPD	NPD	NPD	
- Panel Shear G_v	1080		1080		1080		NPD		NPD		
- Planar Shear G_r	50		50		50		NPD		NPD		
[1]Reaction to Fire (excluding flooring)	[1]D-s2,d0		[1]D-s2,d0		D-s1,d0		D-s1,d0		D-s1,d0		EN 13986:2004 +A1:2015
Reaction to Fire (flooring)	NPD		D_{FL}-s1		D_{FL}-s1		D_{FL}-s1		D_{FL}-s1		
Water Vapour Permeability μ - Wet Cup - Dry Cup	150 240		150 240		150 240		NPD		NPD		
Release of Formaldehyde	E1		E1		E1		E1		E1		
Release (content) of Pentachlorophenol (PCP)	NPD		NPD		NPD		NPD		NPD		
Airborne Sound Insulation (surface mass) (R)	NPD		NPD		NPD		NPD		NPD		
Sound Absorption α (250 – 500 Hz)	0.10		0.10		0.10		0.10		0.10		
Sound Absorption α (1000 – 2000 Hz)	0.25		0.25		0.25		0.25		0.25		
Thermal Conductivity λ	0.11		0.11		0.11		0.11		0.11		

DOP01 Rev3 09/08/16 *Controlled document if stamped 'Controlled Document'.* Page 1 of 2

SMARTPLY
DEFINING THE STANDARD OF OSB

Essential Characteristics	Performance						Harmonised technical specification
Durability:							EN 13986:2004 +A1:2015
Thickness Range (mm)	6 to 10	>10 to <18	18 to 25	>25 to 32	>32 to 40		
Internal Bond (N/mm²)	0.34	0.32	0.30	0.29	0.26		
Swelling in Thickness (%)	15	15	15	15	15		
Moisture Resistance - Internal Bond after Boil Test (N/mm2)	NPD	NPD	NPD	NPD	NPD		
Moisture Resistance - Internal Bond after Cyclic Test (N/mm²)	NPD	NPD	NPD	NPD	NPD		
Bending Strength after Cyclic Test – Major Axis (N/mm²)	9	8	7	6	6		
Mechanical ($creep k_{def}$) Service Class 1	1.50	1.50	1.50	1.50	1.50		
Mechanical ($creep k_{def}$) Service Class 2	2.25	2.25	2.25	2.25	2.25		
Thickness Range (mm)	>6 to 40						
Load-Duration Class	Permanent Action	Long Term Action	Medium Term Action	Short Term Action	Instantaneous Action		
Mechanical (duration of load k_{mod}) Service Class 1	0.40	0.50	0.7	0.90	1.10		
Mechanical (duration of load k_{mod}) Service Class 2	0.30	0.40	0.55	0.70	0.90		
Biological	Use classes 1 & 2						
[2]T&G Products	Spacing	12.5mm T&G	15mm T&G	18mm T&G	22mm T&G	24mm T&G	
[3]Characteristic Point load $F_{max,k}$ (N) *(for floors and roofs)*	400mm	3019	4815	5494	6709	7610	
	600mm	2766	3807	4712	6575	7272	
Point Load Mean Stiffness (N/mm) *(for floors and roofs)*	400mm	395	563	797	1161	1305	
	600mm	188	322	426	669	754	
[3]Characteristic Point Load Serviceability: $F_{max,k}$ (N) *(for floors and roofs)*	400mm	2113	3370	3846	4696	5327	
	600mm	1936	2665	3298	4603	5091	
Soft Body Impact Resistance Floor/roofs	400mm	Class I	Class I	Class I	Class I	Class I	
	600mm	Class II	Class I	Class I	Class I	Class I	
Soft Body Impact Resistance Walls	Spacing			> 9mm			
	400mm			Class III			
	600mm			Class III			

[1] minimum thickness 9mm for thickness range >6 – 10mm & performance D-t1,d0 for 18mm within thickness range >10 to 18

[2] NPD for square edge products

[3] characteristic means lower 5th percentile calculated according to EN 1058

The performance of the product identified is in conformity with the declared performance. This declaration of performance is issued under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:

Frank Fogarty 09/08/2016

Frank Fogarty, Quality Assurance Specialist. Waterford, Ireland. 9th August 2016.

DOP01 Rev3 09/08/16 *Controlled document if stamped 'Controlled Document'.* Page 2 of 2

GYPSUM Board

Primary WUFI material file based on Gypsum Board sourced from the Fraunhofer IBP material library.

Appendix B: U values Assessment

While WUFI provides a U value assessment for the construction, as this does not account for bridging it does not provide an accurate output.

BuildDesk U software (version 3.4) was used to confirm the U value of the roof. BuildDesk U 3.4 is Software developed by BuildDesk Ltd in the United Kingdom.

A U value of **0.17 W/m2k** was assessed for the assembly following an assessment in adherence with BR 443 2006 Edition: Conventions for U value calculations by Brian Anderson BRE.

A default fraction of 0.09 was taken for the rafters in accordance with guidelines as set out in section 4.6.1 of this guidance paper (see excerpt below).

4.6.1 Ceiling joists

Trussed rafters – 35 mm joists at 600 mm centres (35/600):	**0.058**
50 mm joists at 400 mm centres (50/400):	**0.125**
Add for additional timbers (noggings, loft hatch etc):	**1% (0.01)**

In the absence of specific information use the following default fraction (based on 48 mm timbers at 600 mm centres, 48/600 + 0.01).

Default fraction for ceiling joists:	**0.09**

If air gaps are ignored a U value of 0.16W/m2K is attained. This value may be optimistic.

It was anticipated that due to the nature of the insulation been rigid, and the likelihood that the timber members will feature distortions, and potential movement/shrinkage over tme, some element of air gaps must be accounted for. A correction due to air gaps of level 1 was deemed adequate.

4.9.1 Corrections due to air gaps

Annex D of BS EN ISO 6946 recognises three levels of correction for air gaps in an insulation layer. The levels are:

Level 0: ΔU = 0.00
There must be no gaps exceeding 5 mm width penetrating the insulation layer. This applies for double layer insulation, and single layer boards with lapped or sealed joints or with dimensional tolerances such that no gap will exceed 5 mm.

Level 1: ΔU = 0.01
A correction for air gaps is needed if:
- the sum of the length or width tolerance and the dimensional stability of the insulation boards is more than 5 mm, or
- the squareness tolerance of the insulation boards, batts or slabs is more than 5 mm.

Level 2: ΔU = 0.04
Air gaps as in Level 1, and also air circulation possible on the warm side of the insulation layer. It applies, for example, to partial cavity fill with insulation boards if the boards are not affixed to the inner leaf.

ecological
BUILDING SYSTEMS LTD

Niall Crosson
Group Technical Manager BTech, MEngSc, MIEI, CEPHC

Documentation of the component
Thermal transmittance (U-value) according to BS EN ISO 6946
Source: **own catalogue - Pitched roofs**
Component: **ENEN9105_MrandMrsBlackRoof**

30. May 2018
Page 1 /8

OUTSIDE

This illustration of inhomogeneous layers is provided only to assist in visualising the arrangement.

On the basis of the given information about the inhomogeneous layers, it is not possible to estimate how and where bearing elements intersect each other. It was assumed that the layers intersect crosswise. The size of the areas was calculated corresponding to their percentage of the whole area.

INSIDE

Assignment: Pitched roof < 70°, with integral insulation

		Manufacturer	Name	Thickness [m], number	Lambda [W/(m K)]	Q	R [m²K/W]
		Rse					0.1000
☐	1	BS EN 12524	Slate [2000 kg/m³] & Mortar outer leaf (f= 0.000 / automatic determination regarding acc. BRE 4.4.3)	0.0030	2.200	D	0.0014
☐	2	Inhomogeneous material layer	consisting of:	0.0440	ø 0.016		2.8286
	2a	BS EN ISO 6946	Ventilated air layer	88.00 %	0.000	D	-
	2b	BS EN 12524	Softwood Timber [500 kg/m³]	12.00 %	0.130	D	-
☑	3	pro clima	Solitex PLUS	0.0007	0.100	E	0.0065
☑	4	Eco Building Systems Air gaps	ACME White EPS 100 Level 1: dU* = 0.01 W/(m²K)	0.0500	0.036	E	1.3889
☑	5	Smartply	DOP_Smartply OSB3	0.0180	0.110	E	0.1636
☑	6	Inhomogeneous material layer	consisting of:	0.1650	ø 0.040		4.1343
	6a	ACME Air gaps	ACME Grey EPS 70 Level 1: dU* = 0.01 W/(m²K)	91.00 %	0.031	E	-
	6b	BS EN 12524	Softwood Timber [500 kg/m³]	09.00 %	0.130	D	-
☑	7	General Building Materials Rsi	Standard wallboard plasterboard	0.0125	0.210	D	0.0595 0.1000
				0.2582			

☐ was not taken into consideration in the calculation

ecological
BUILDING SYSTEMS LTD

Niall Crosson
Group Technical Manager BTech, MEngSc, MIEI, CEPHC

Documentation of the component
Thermal transmittance (U-value) according to BS EN ISO 6946
Source: **own catalogue - Pitched roofs**
Component: **ENEN9105_MrandMrsBlackRoof**

30. May 2018
Page 2/8

$R_T = (R_T' + R_T'')/2 = 6.17\ m^2K/W$

Correction to U-value for	according to	delta U [W/(m²K)]
Air gaps	BS EN ISO 6946 Annex D	0.005
		0.005

$U = 1/R_T + \Sigma\Delta U = 0.17\ W/(m^2K)$

Q .. The physical values of the building materials has been graded by their level of quality. These 5 levels are the following
A .. A: Data is entered and validated by the manufacturer or supplier. Data is continously tested by 3rd party.
B .. B: Data is entered and validated by the manufacturer or supplier. Data is certified by 3rd party
C .. C: Data is entered and validated by the manufacturer or supplier.
D .. D: Information is entered by BuildDesk without special agreement with the manufacturer, supplier or others.
E .. E: Information is entered by the user of the BuildDesk software without special agreement with the manufacturer, supplier or others.

U = 0.17 W/(m²K) R_T= 6.17 m²K/W

Calculated with BauBook 3.4.5

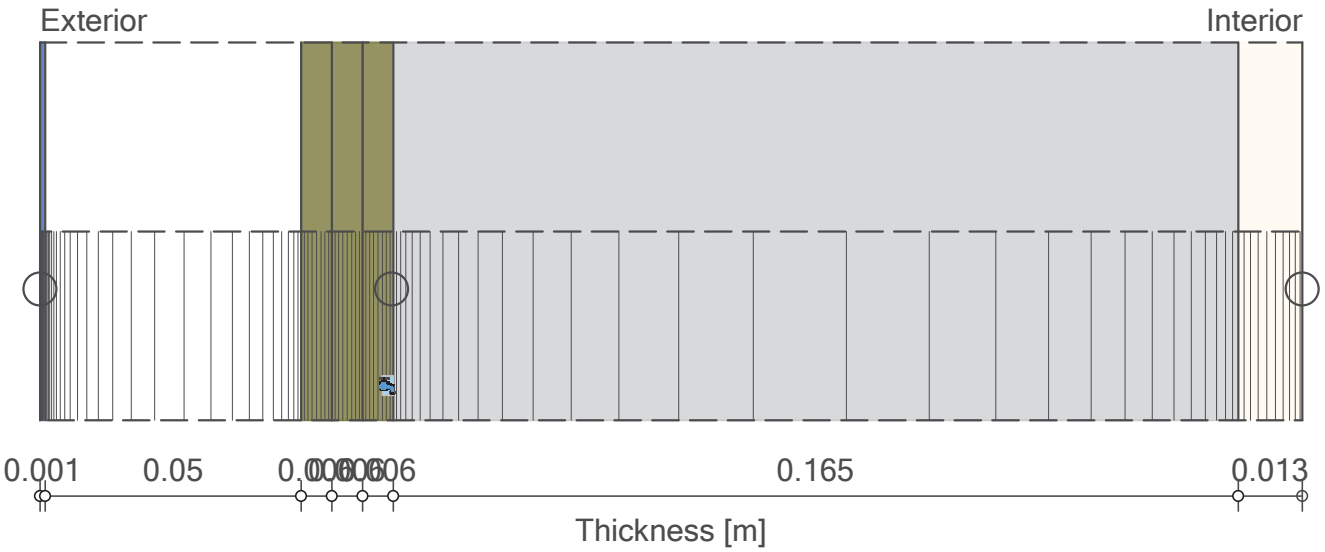
Appendix C: WUFI Data Output Report

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #1 North Pitched Roof with medium internal moisture load & 10ACH



- Monitor positions

- Heat/Moisture source/sink positions

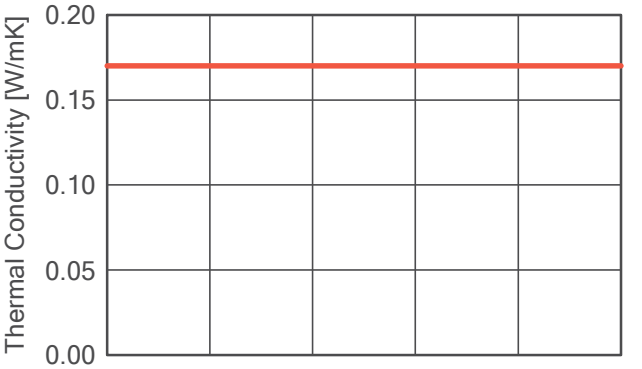
Materials:

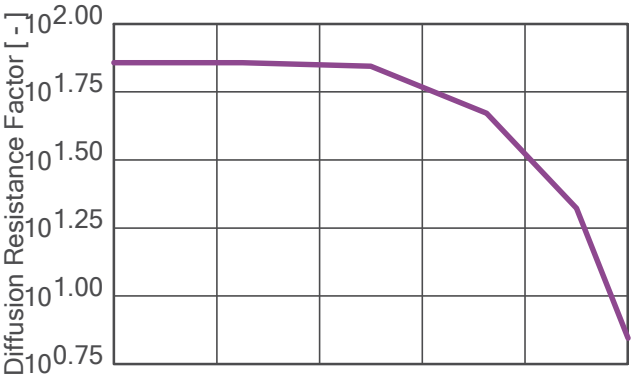
- *SOLITEX PLUS	0.001 m
- *ACME White EPS 100	0.05 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *ACME EPS Silver 70	0.165 m
- Gypsum Board	0.013 m

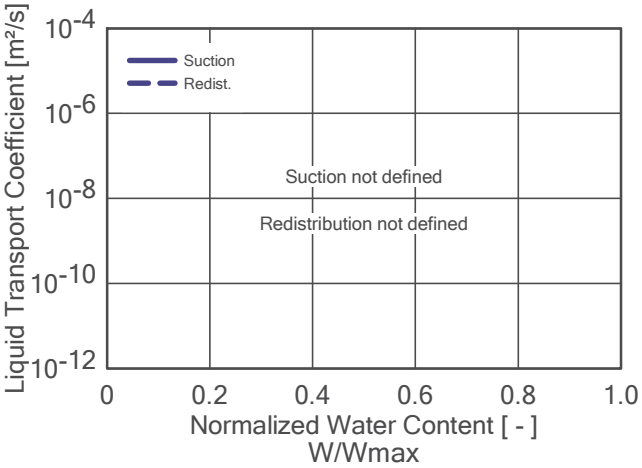
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

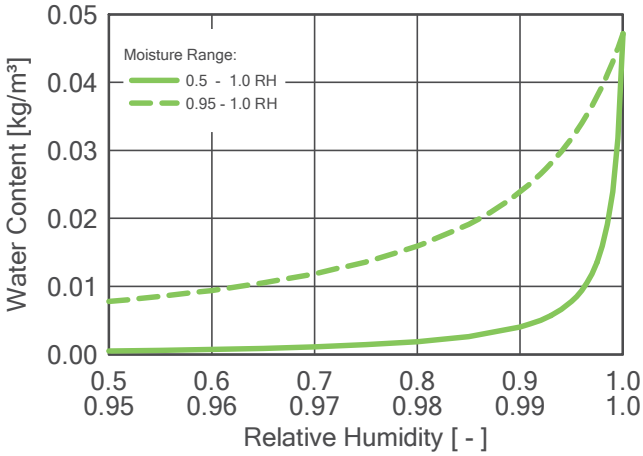
Material: *SOLITEX PLUS

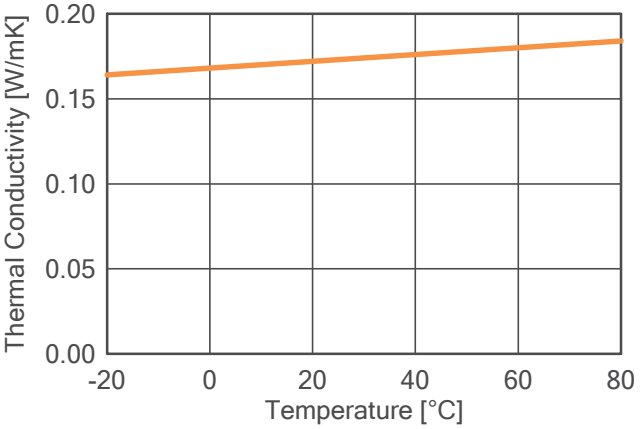
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





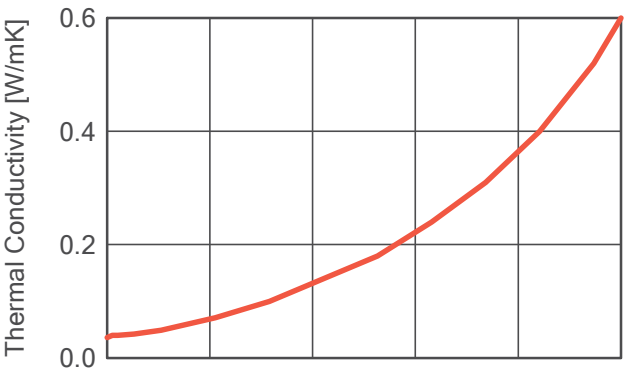


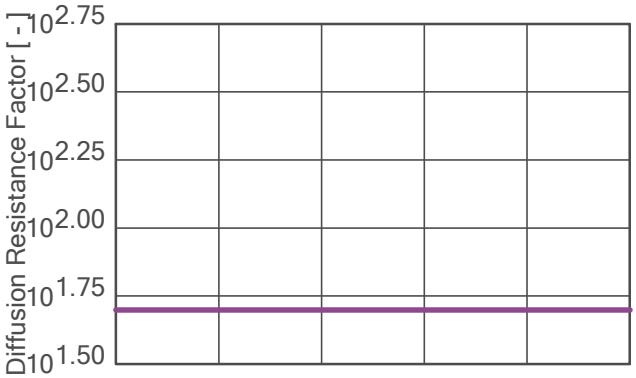


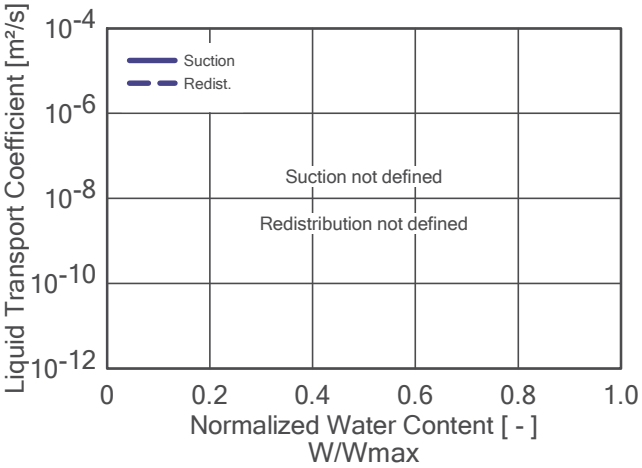


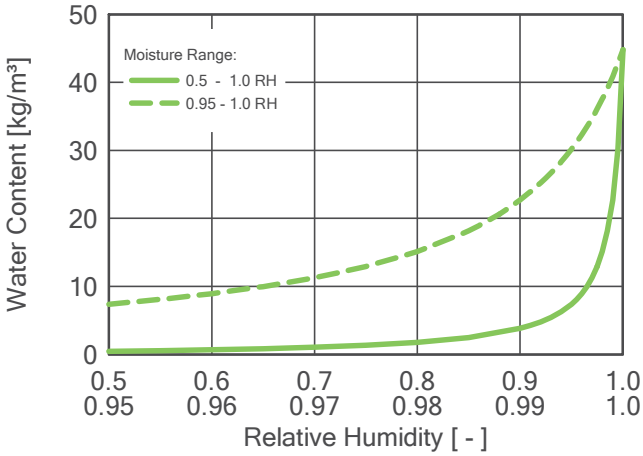
Material: *ACME White EPS 100

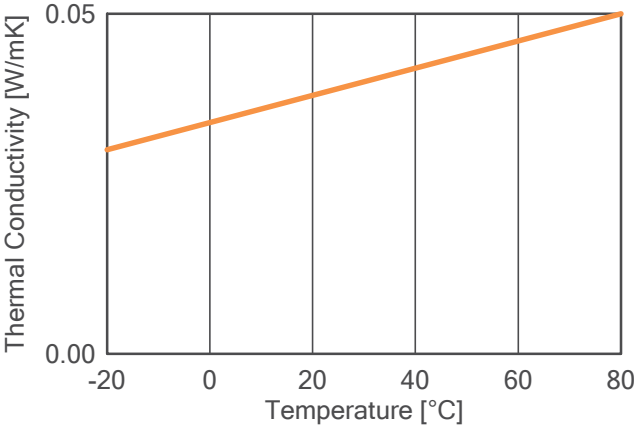
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





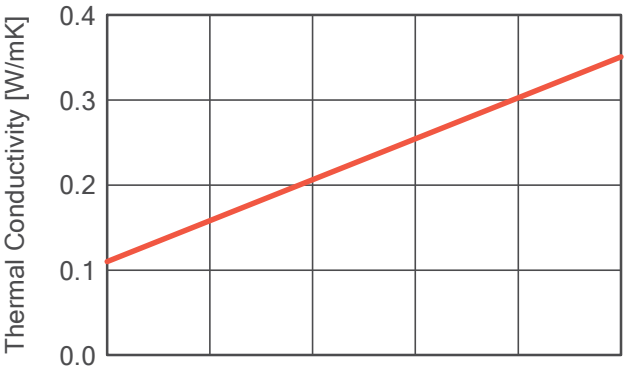


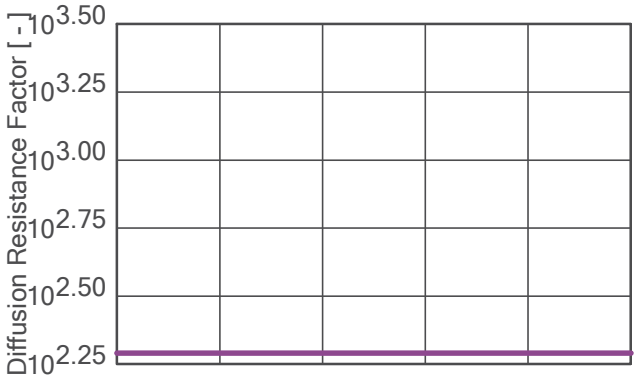


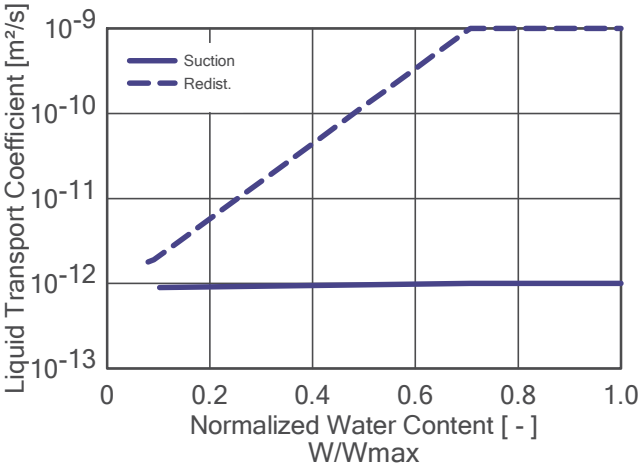


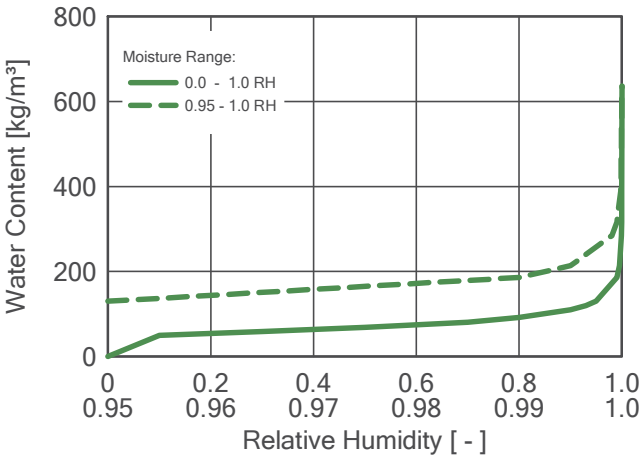
Material: *Smartply OSB3

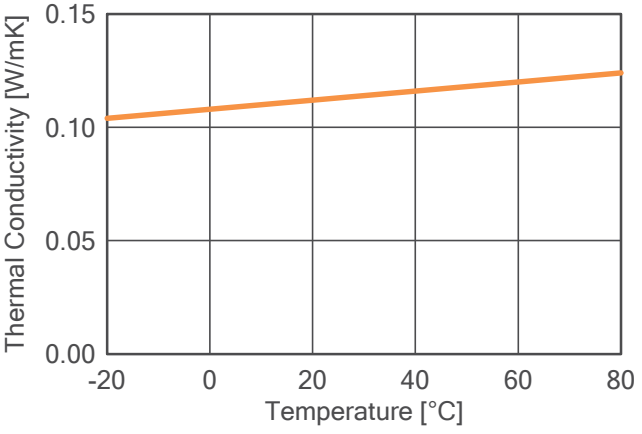
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





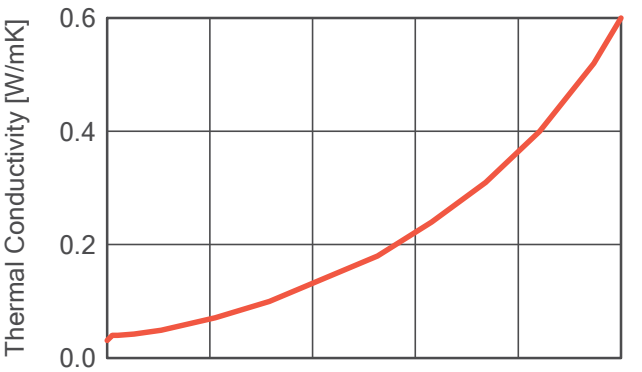


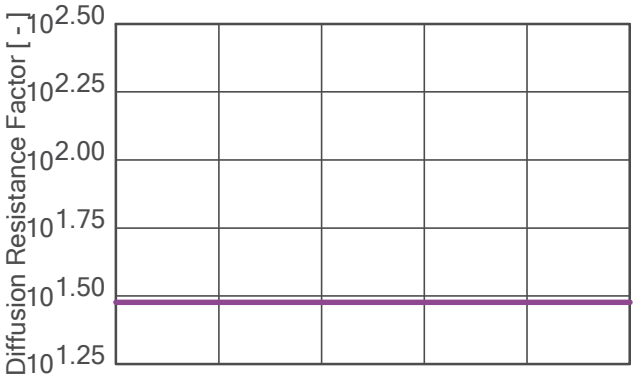


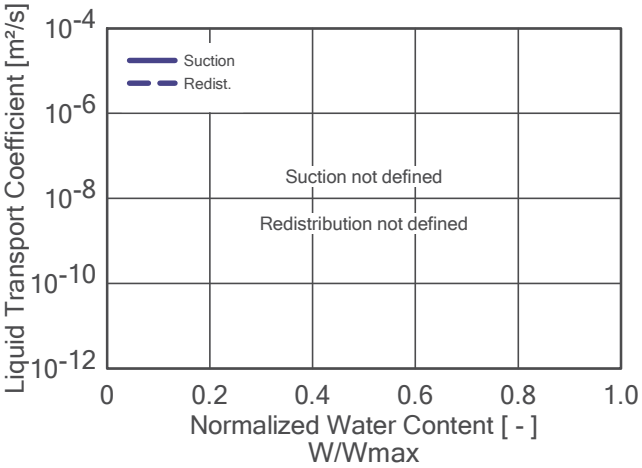


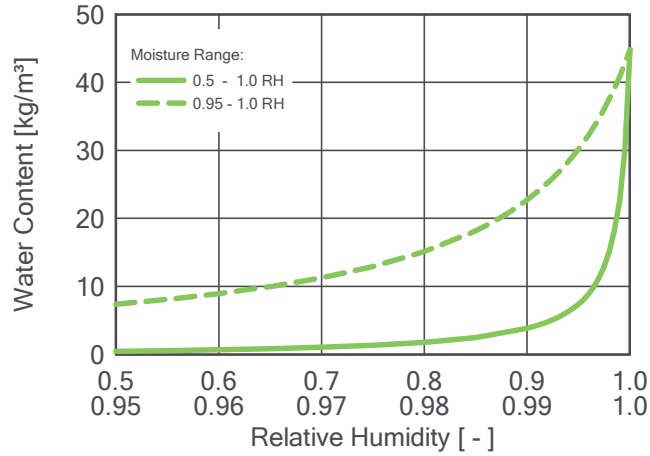
Material: *ACME EPS Silver 70

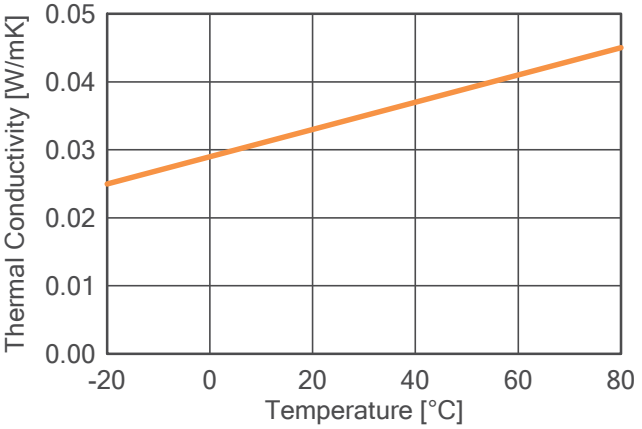
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





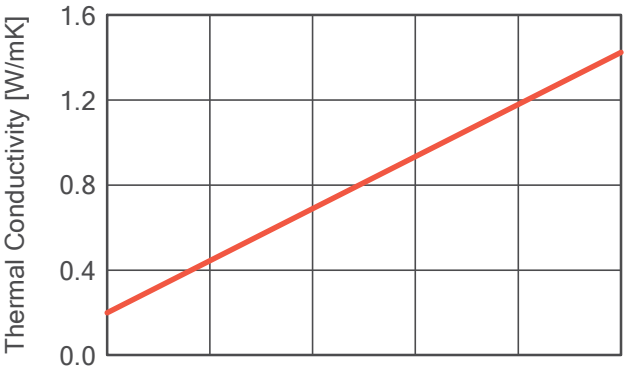


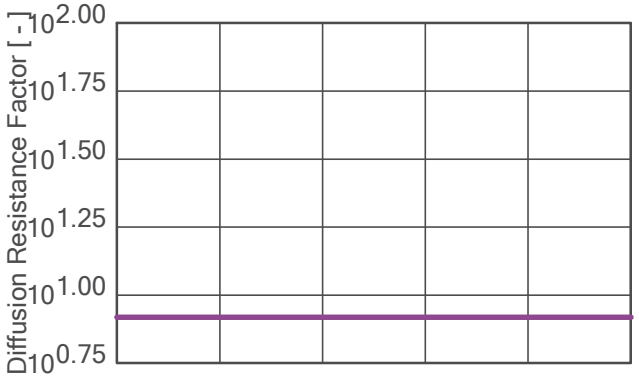


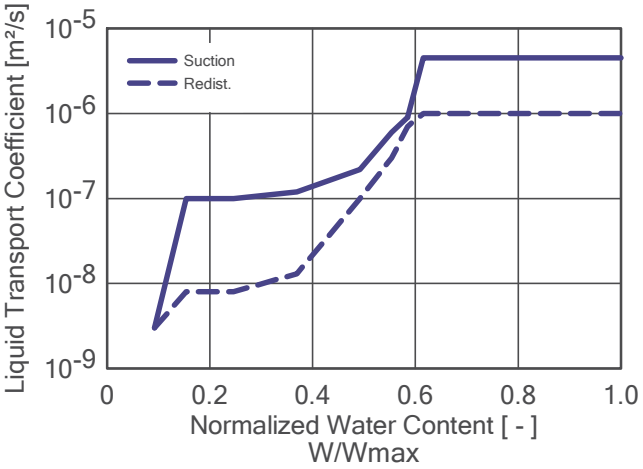


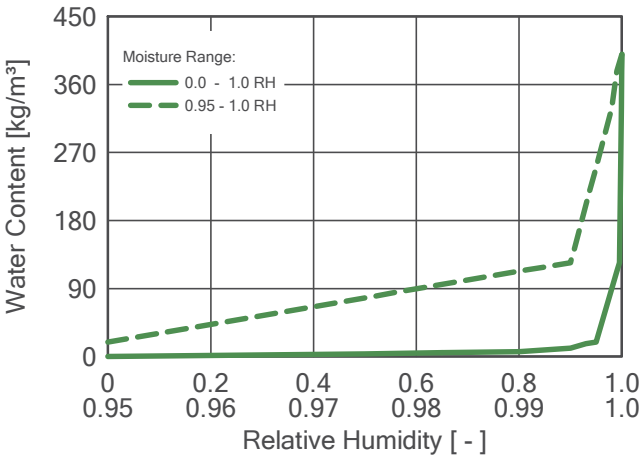
Material: Gypsum Board

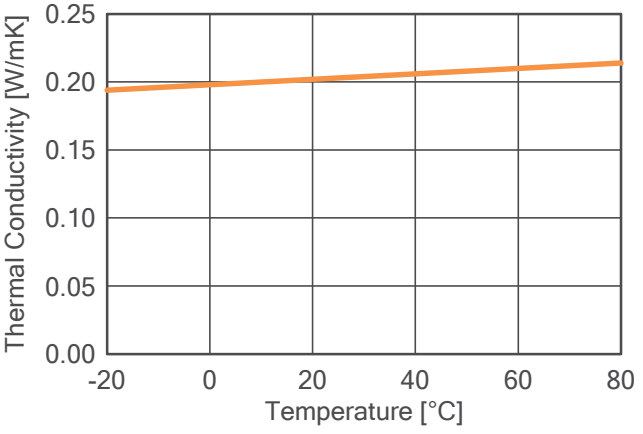
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	North / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 Medium Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 12:24:45
Computing Time	1 min,35 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	1

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -0.55
Integral of fluxes, right side (kr,dr)	[kg/m²]	4.2E-8 -0.06
Balance 1	[kg/m²]	-0.45
Balance 2	[kg/m²]	-0.48

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	2.12	1.67	1.55	2.12

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.18
*ACME White EPS 100	1.79	1.67	0.32	3.73
*Smartply OSB3	92.00	79.48	73.72	92.30
*Smartply OSB3	92.00	78.68	75.66	94.72
*Smartply OSB3	92.00	78.82	75.93	97.96
*ACME EPS Silver 70	1.79	0.70	0.66	1.79
Gypsum Board	6.30	3.97	2.85	6.30

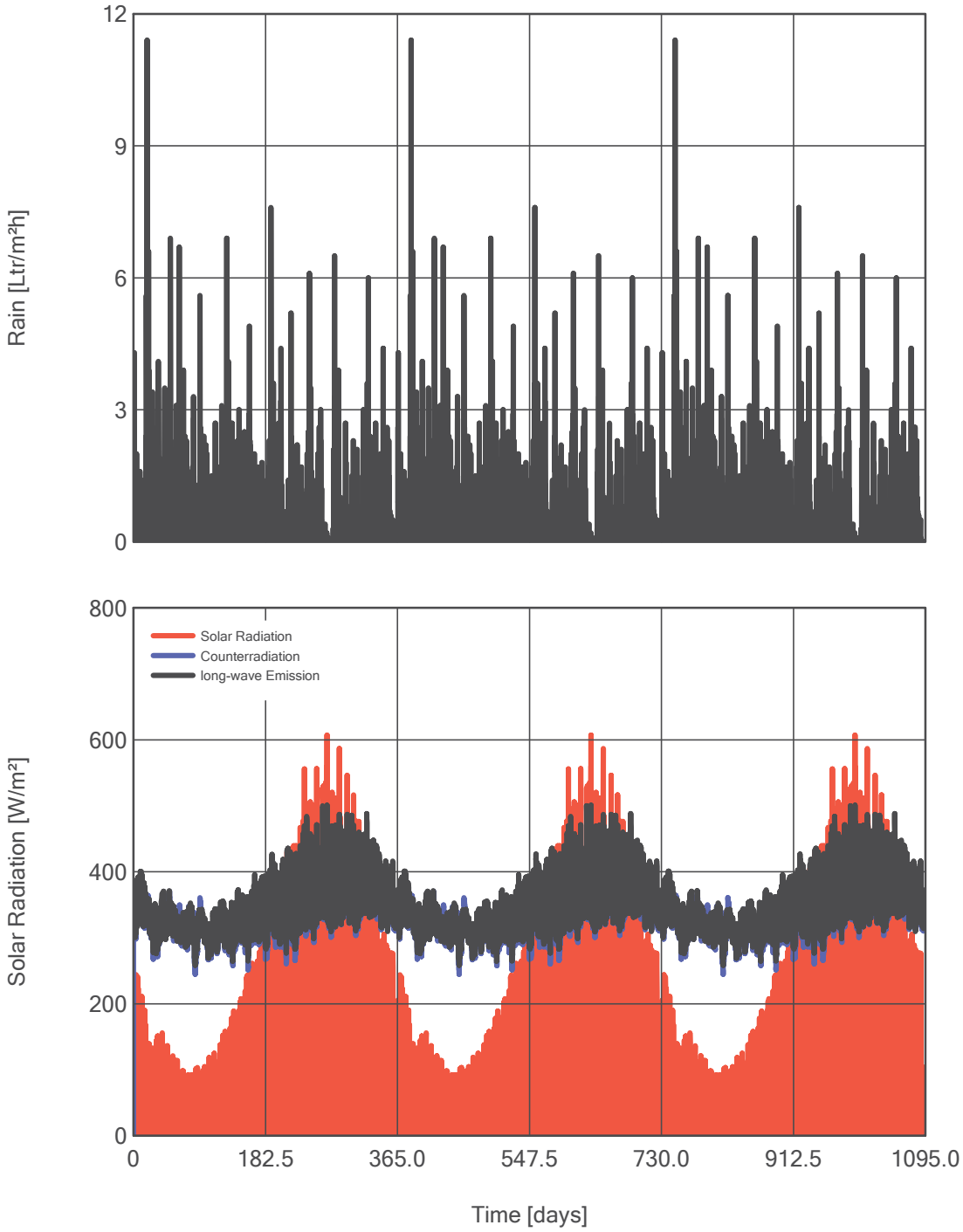
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-1726.69
Heat Flux, right side	[MJ/m²]	-123.65
Moisture Fluxes, left side	[kg/m²]	31.47
Moisture Fluxes, right side	[kg/m²]	-0.05

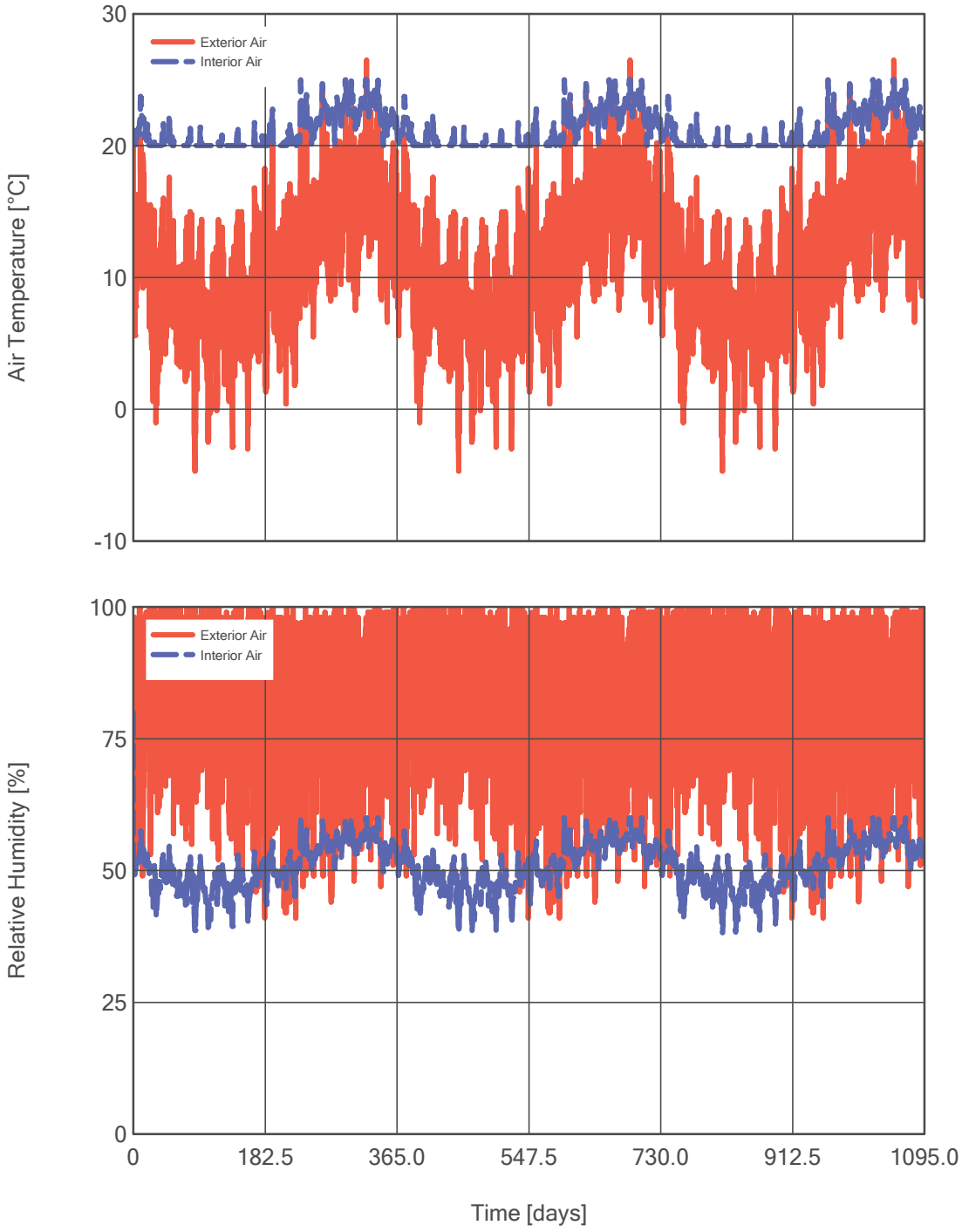
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.018
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.018

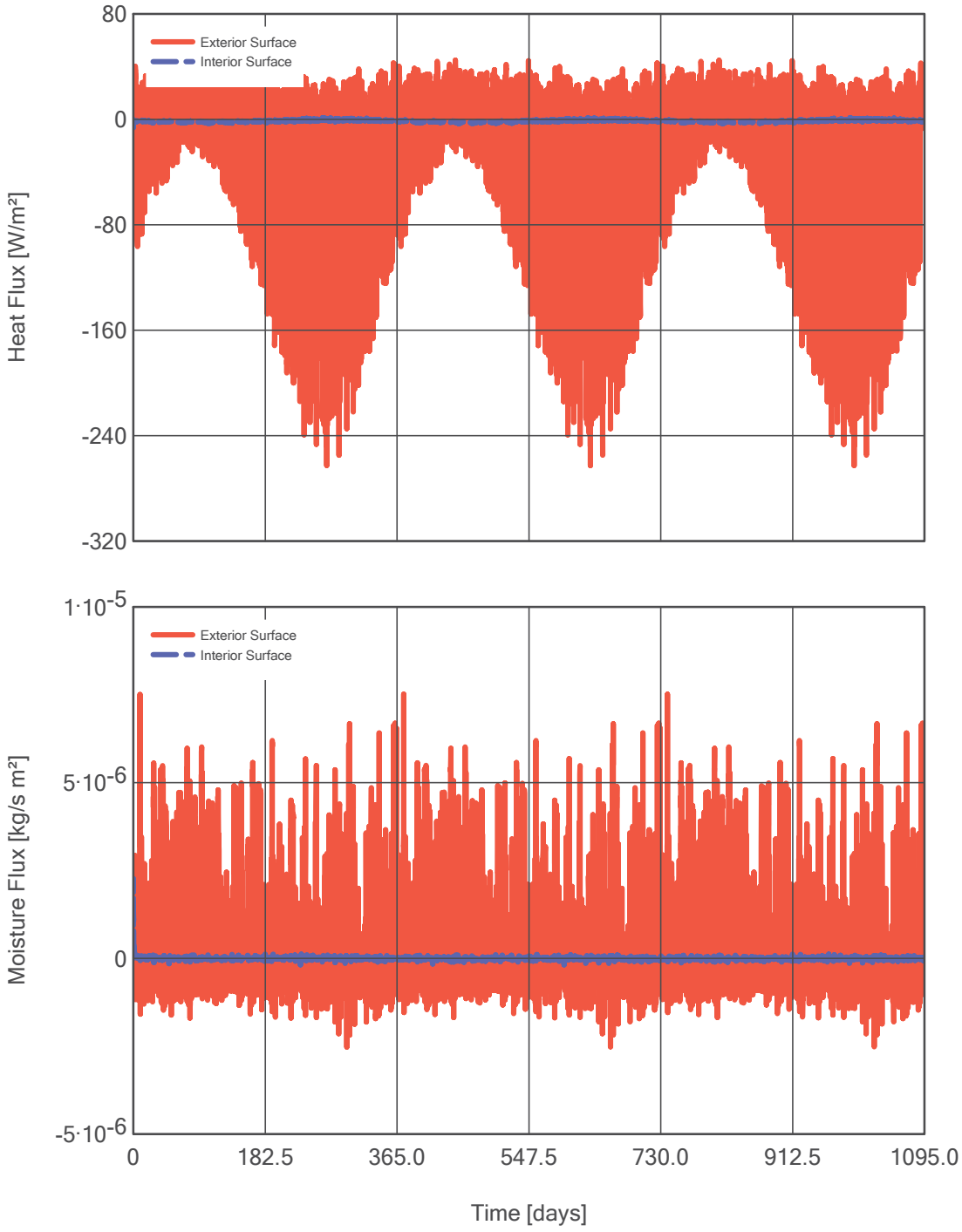
Rain, Radiation (Exterior Climate)



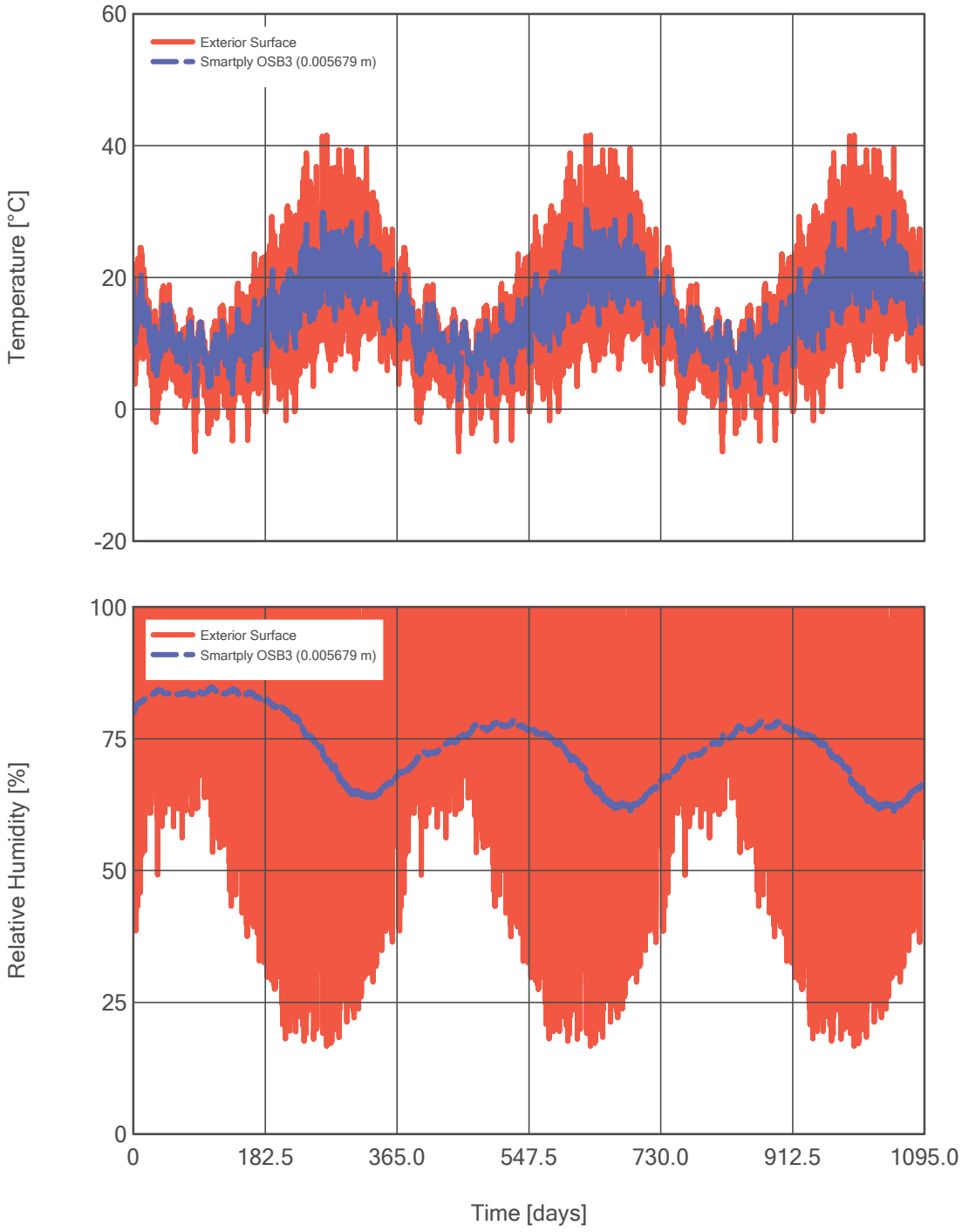
Air Temperature, RH (Exterior, Interior)



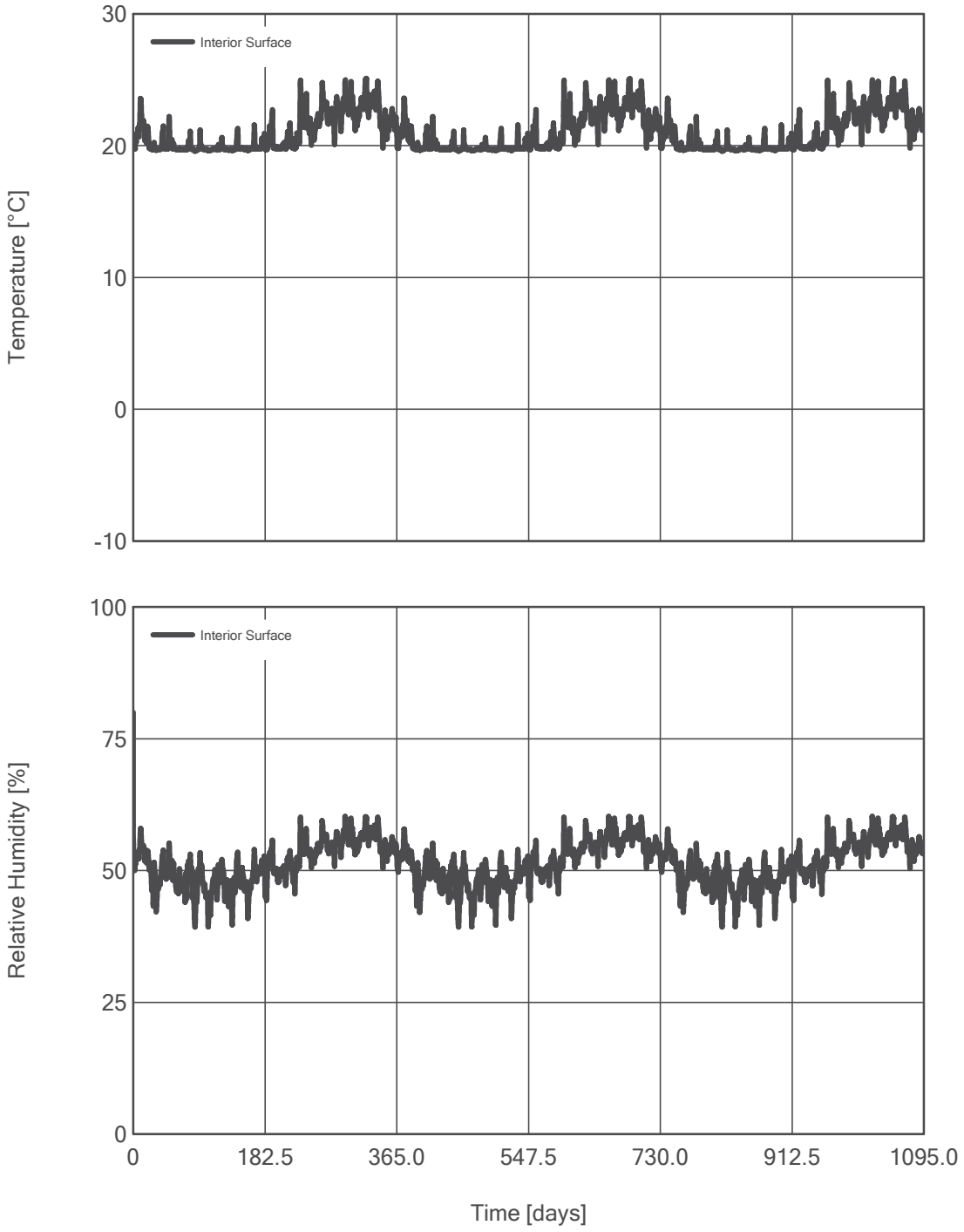
Heat, Moisture Fluxes



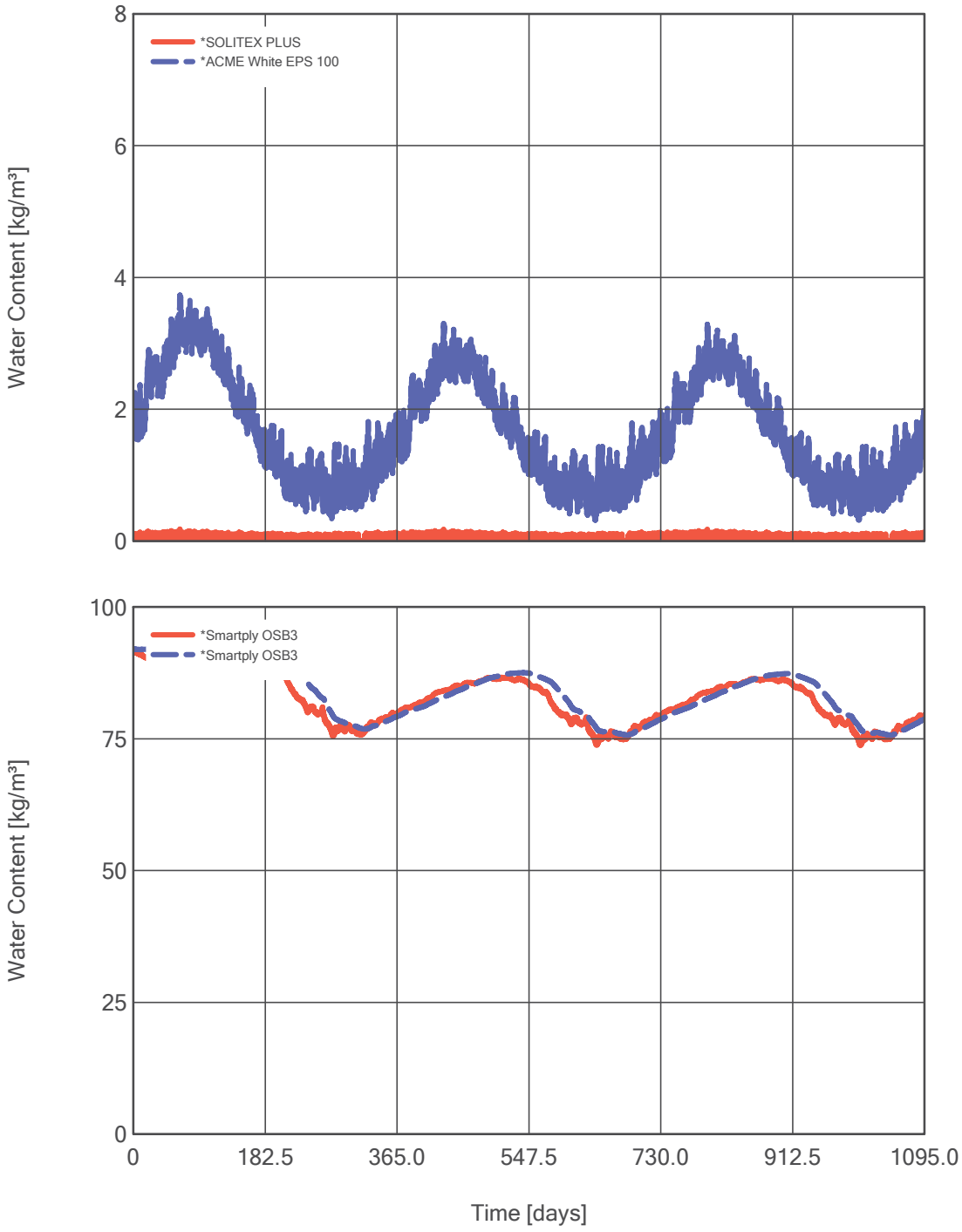
Temperature, RH (Monitor Position 1, 2)



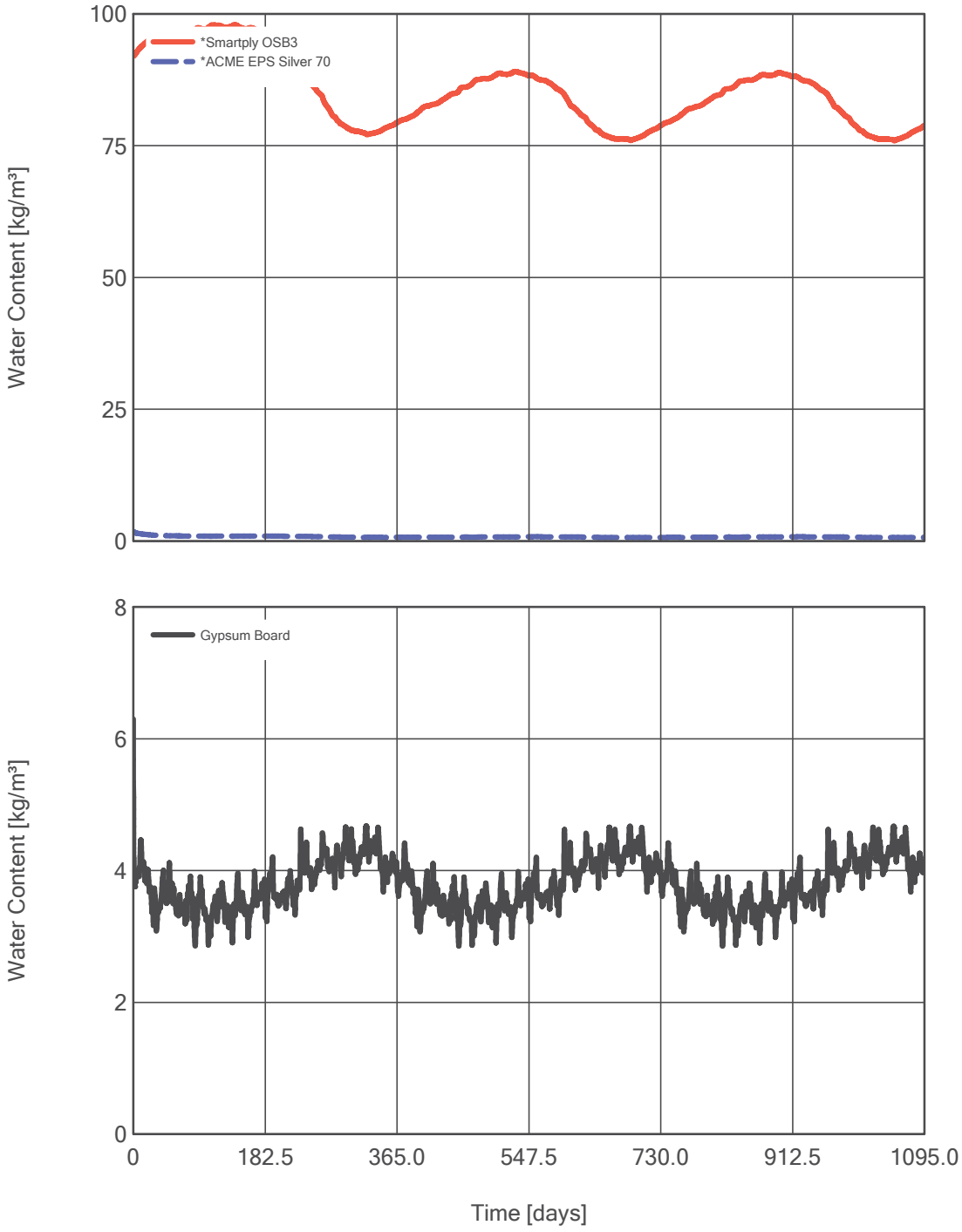
Temperature, RH (Monitor Position 3)



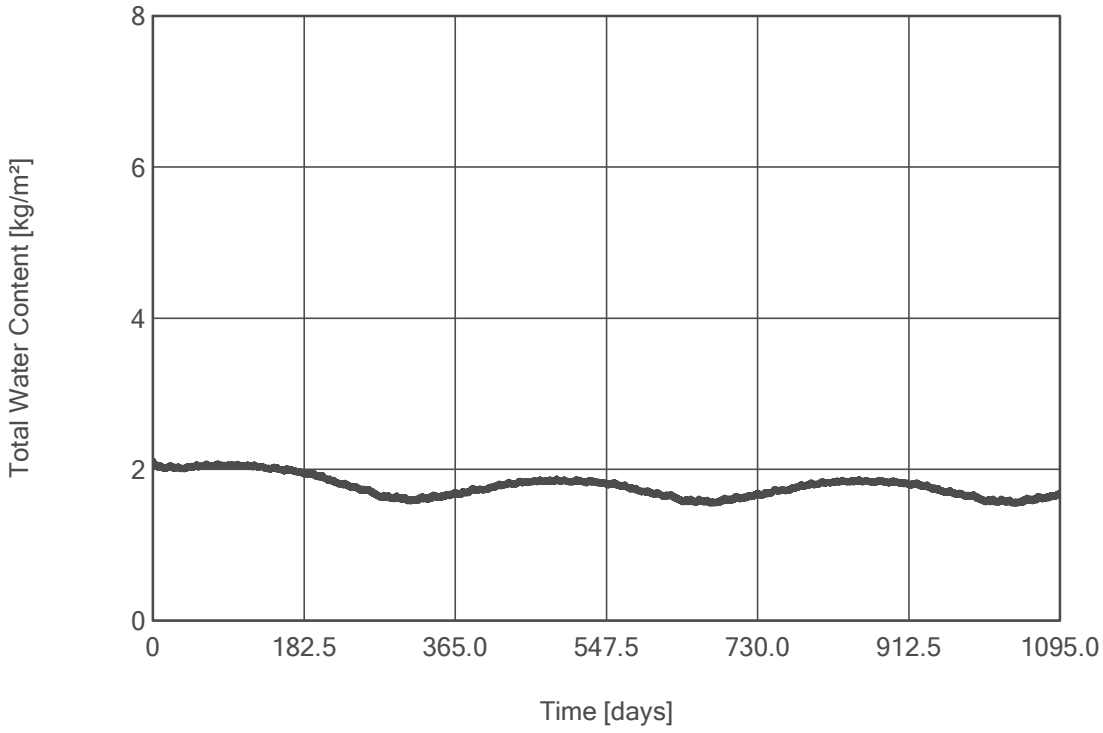
Water Content of Individual Materials



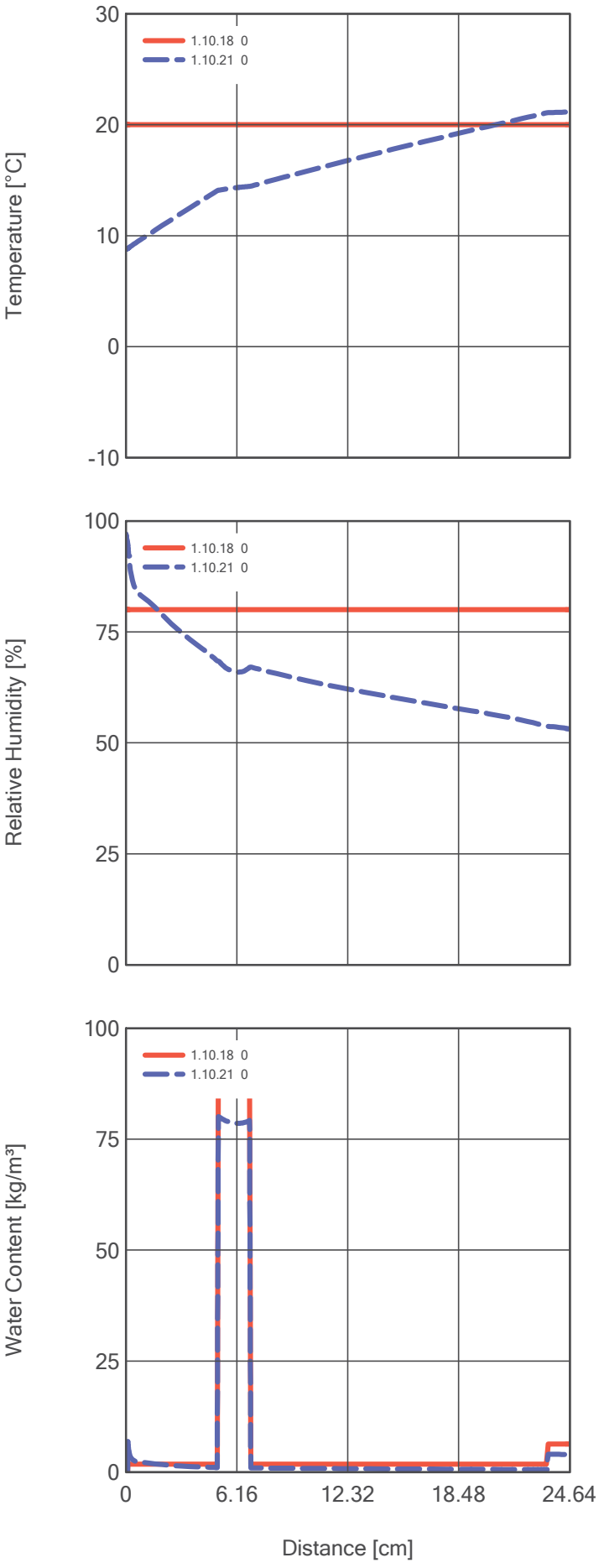
Water Content of Individual Materials



Total Water Content in Construction



Profiles

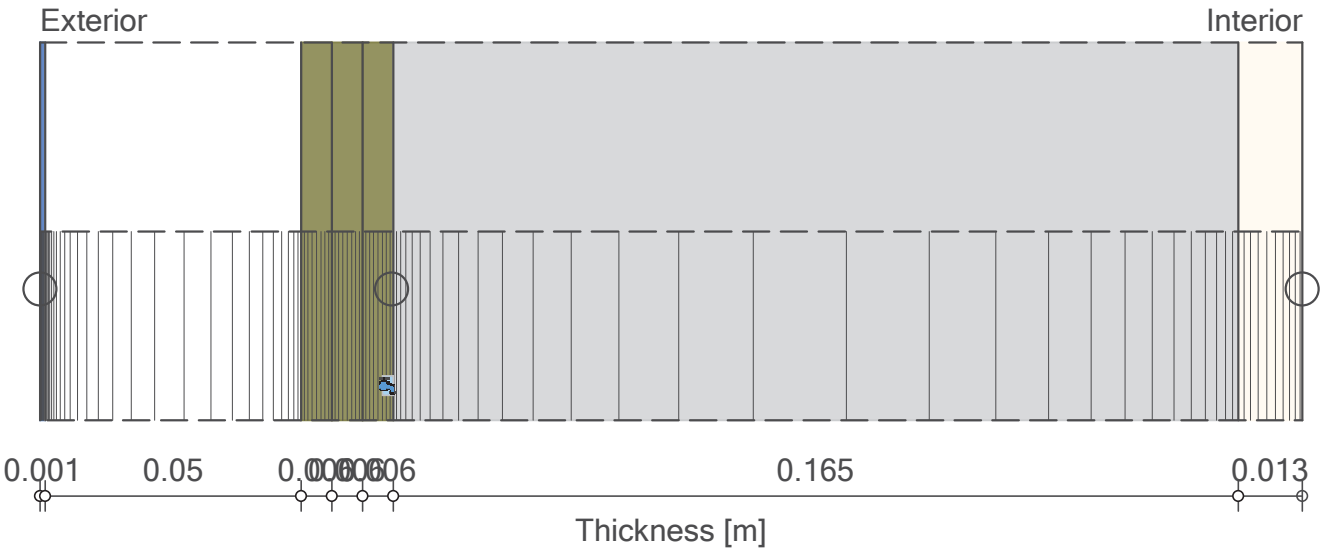

30
20
10
0
-10
Temperature [°C]
1.10.18 0
1.10.21 0
100
75
50
25
0
Relative Humidity [%]
1.10.18 0
1.10.21 0
100
75
50
25
0
Water Content [kg/m³]
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #2 South Pitched Roof with medium internal moisture load & 10ACH



- Monitor positions

- Heat/Moisture source/sink positions

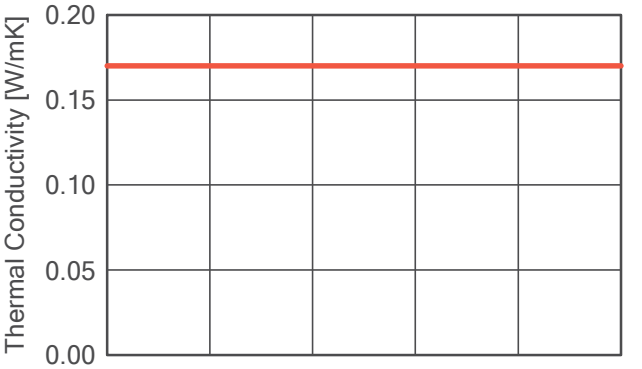
Materials:

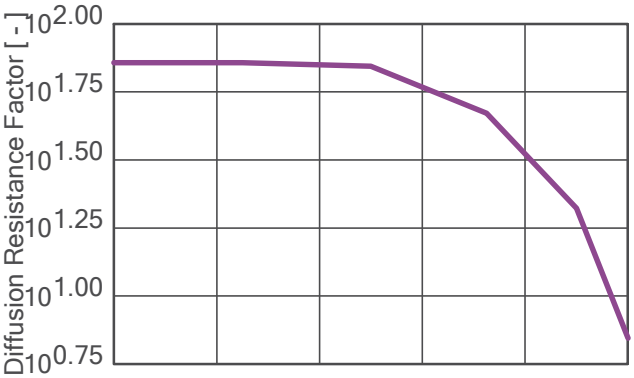
	- *SOLITEX PLUS	0.001 m
	- *ACME White EPS 100	0.05 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *ACME EPS Silver 70	0.165 m
	- Gypsum Board	0.013 m

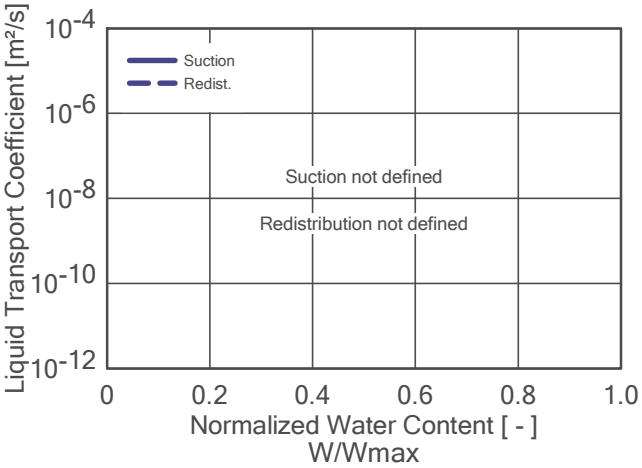
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

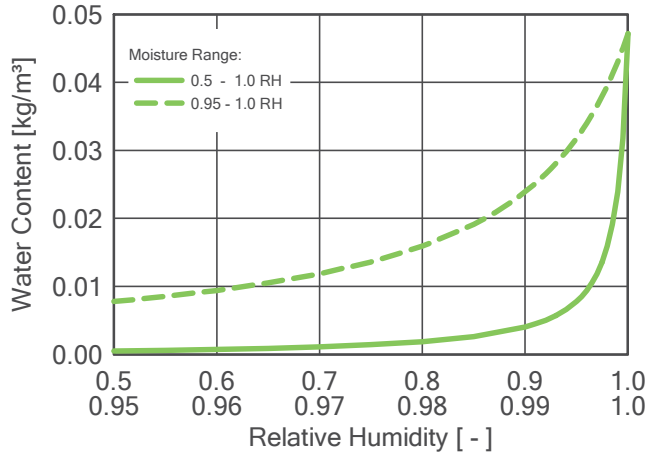
Material: *SOLITEX PLUS

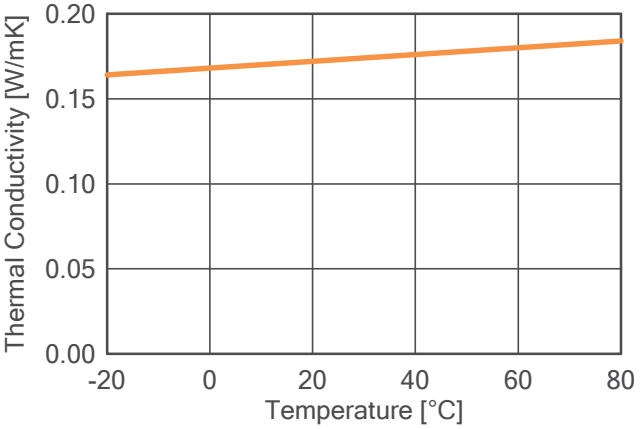
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





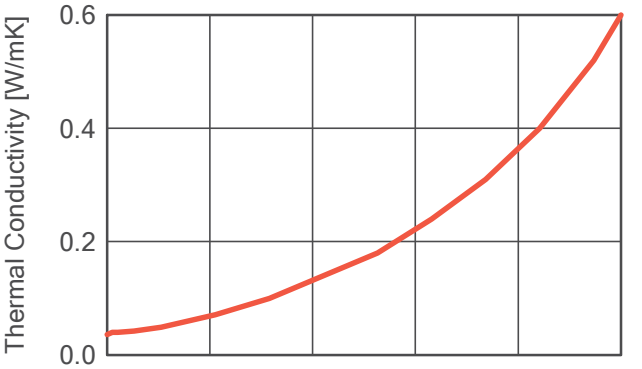


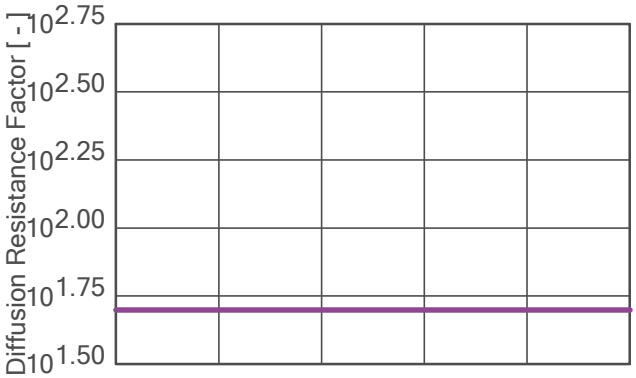


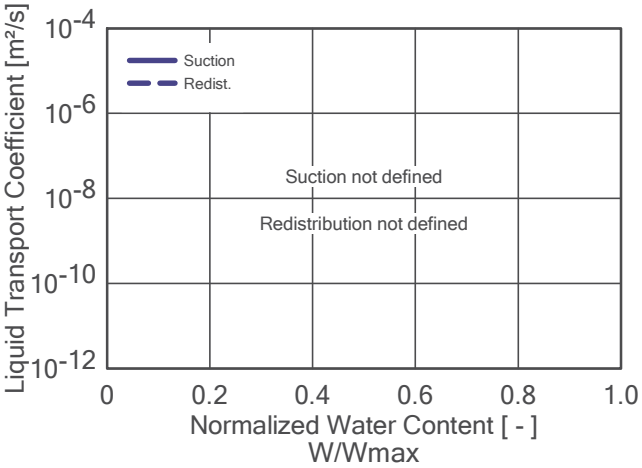


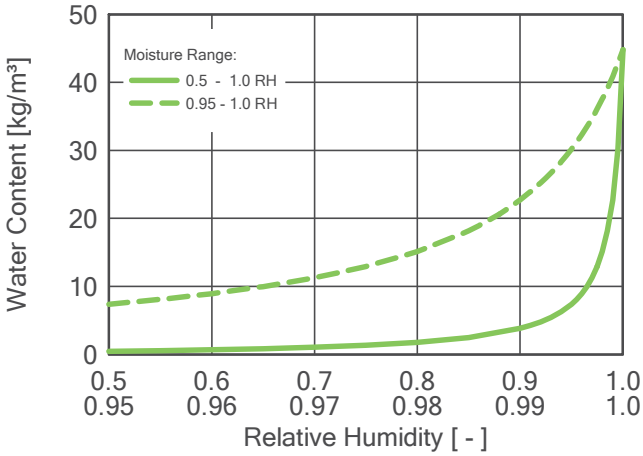
Material: *ACME White EPS 100

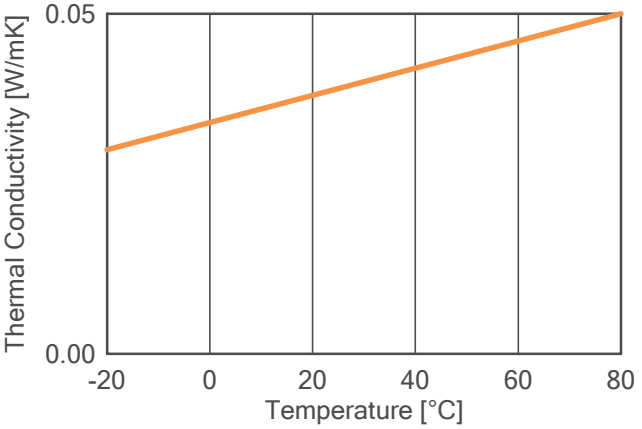
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





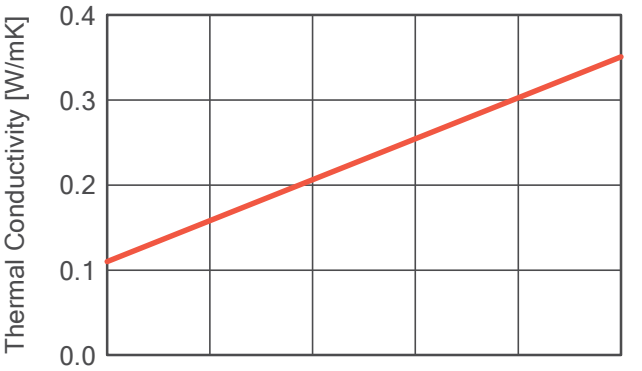


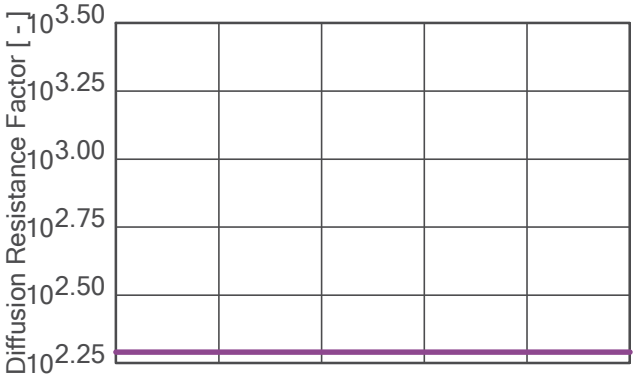


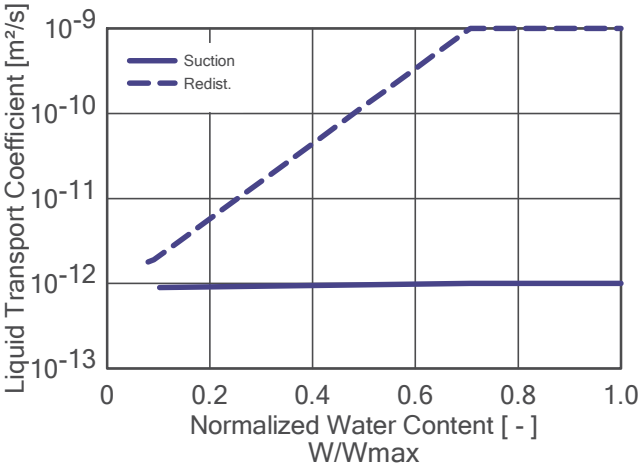


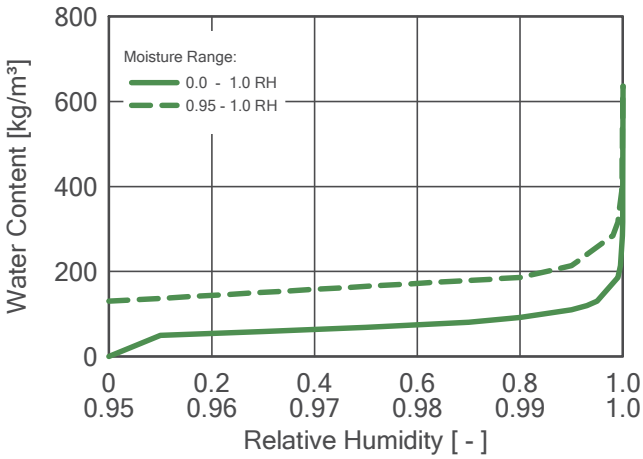
Material: *Smartply OSB3

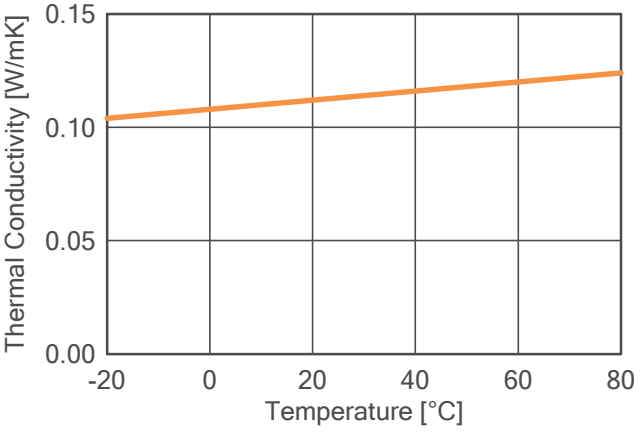
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





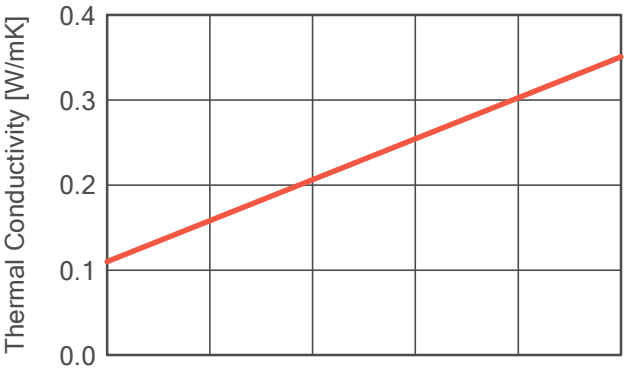


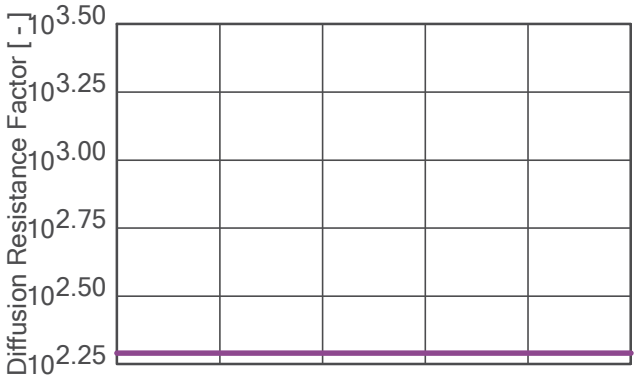


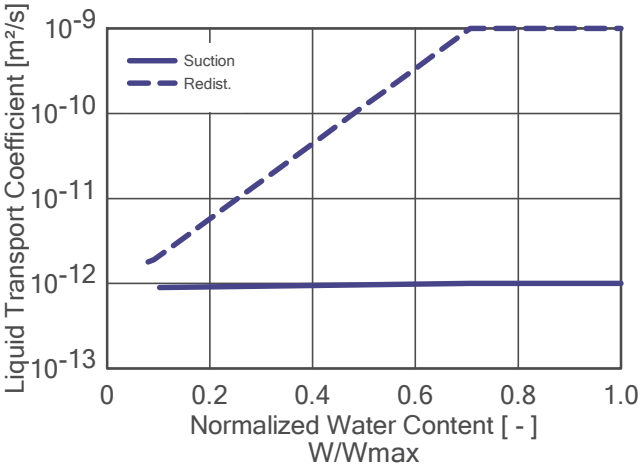


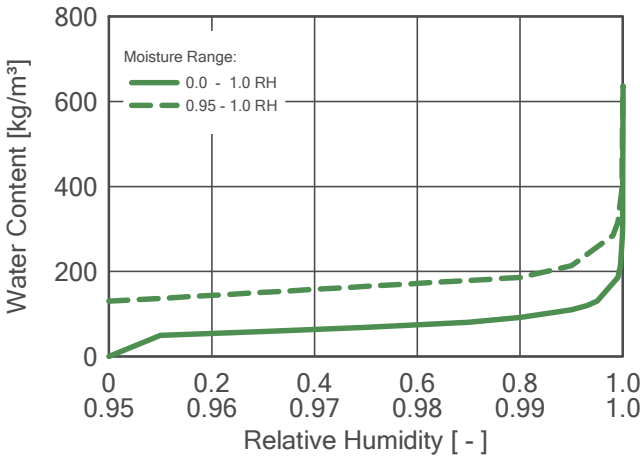
Material: *Smartply OSB3

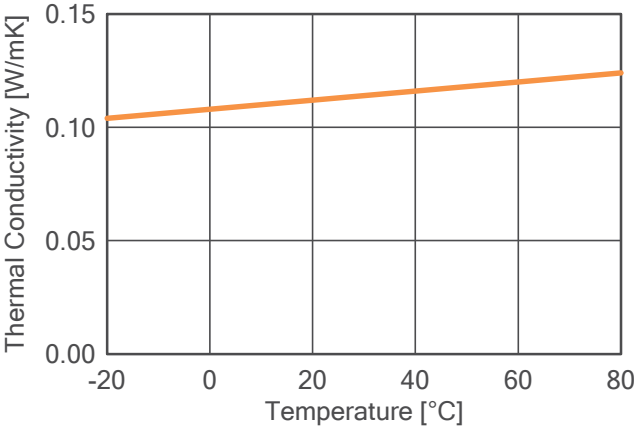
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





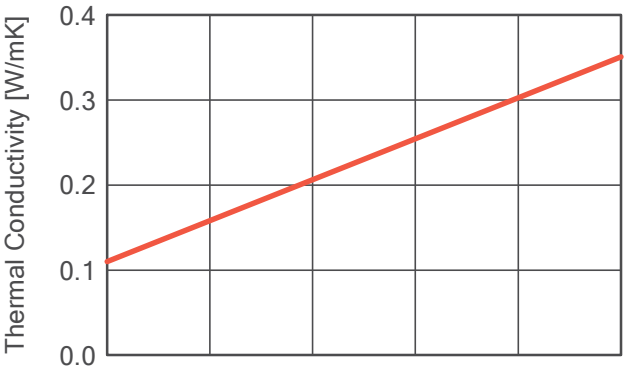


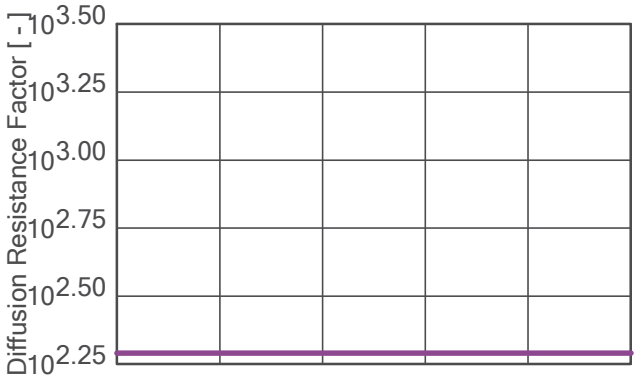


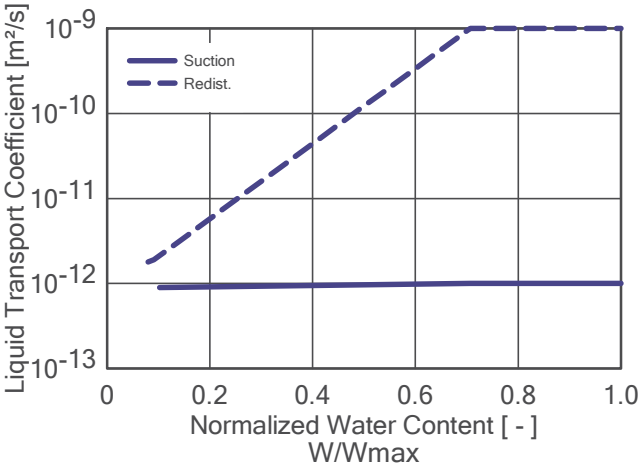


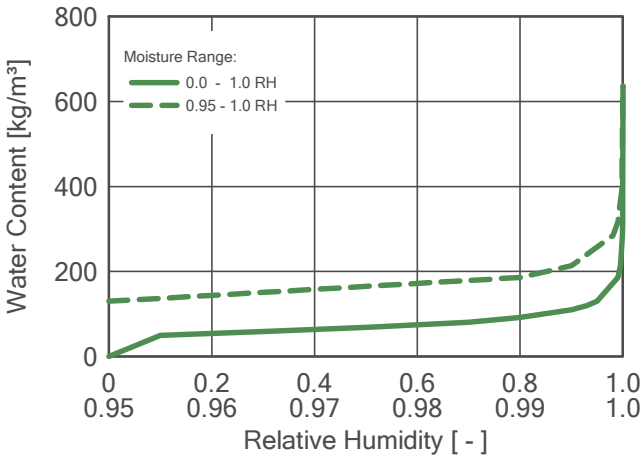
Material: *Smartply OSB3

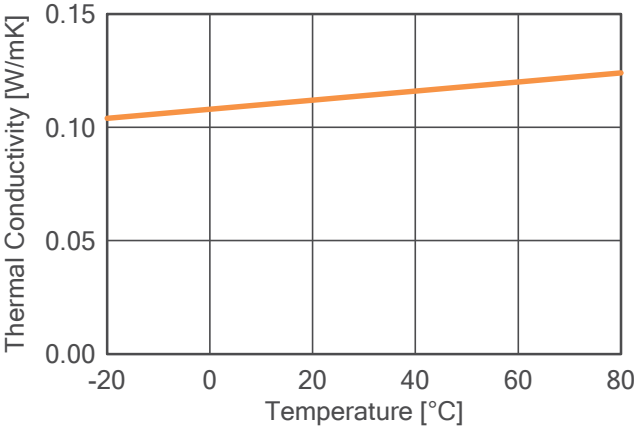
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





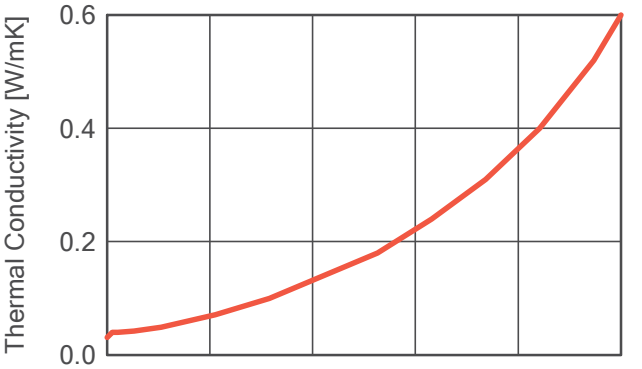


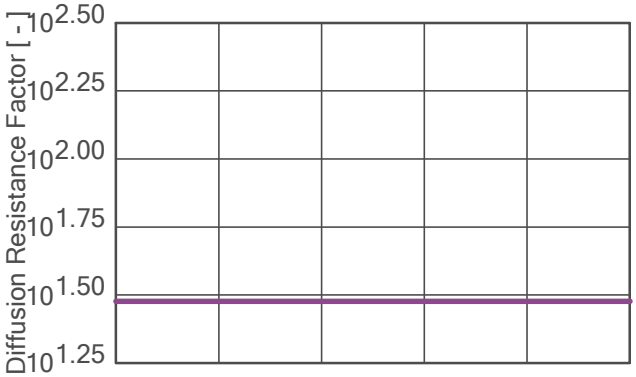


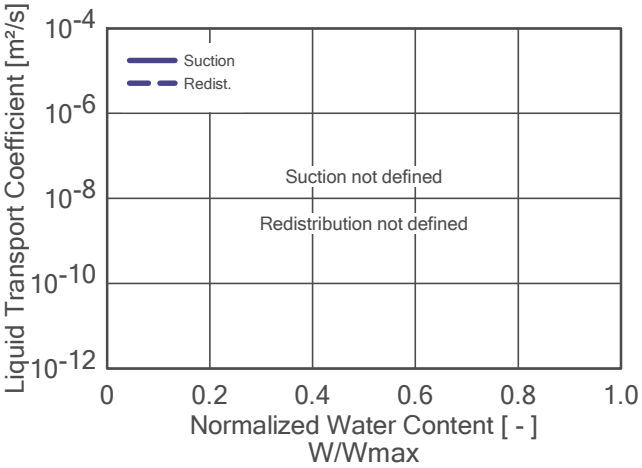


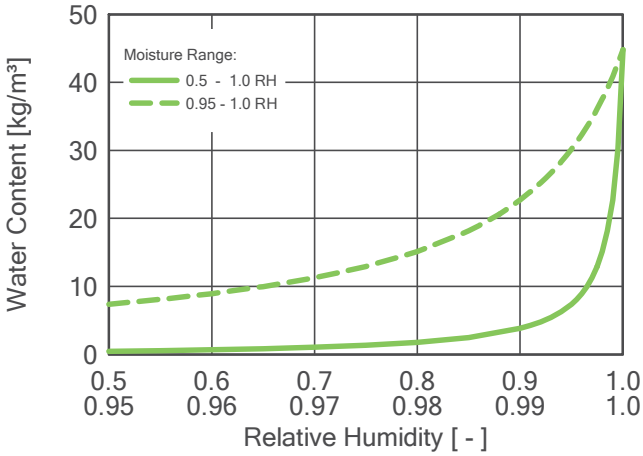
Material: *ACME EPS Silver 70

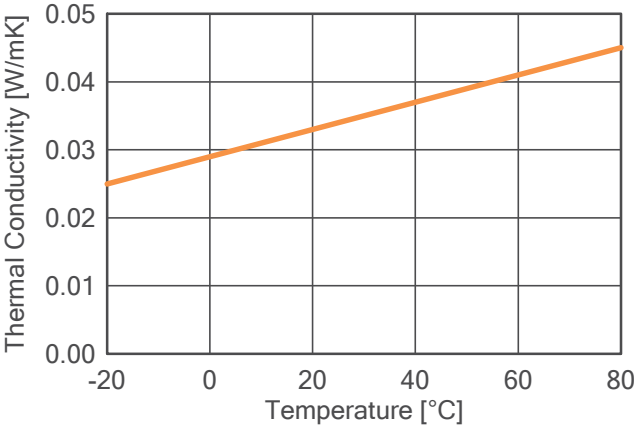
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





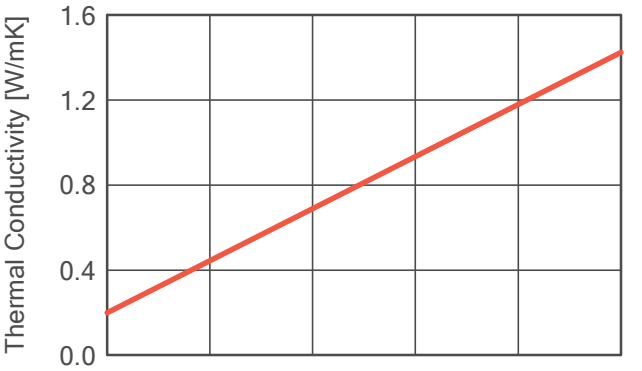


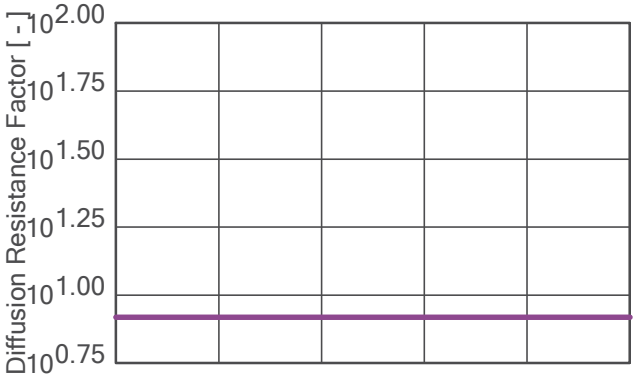


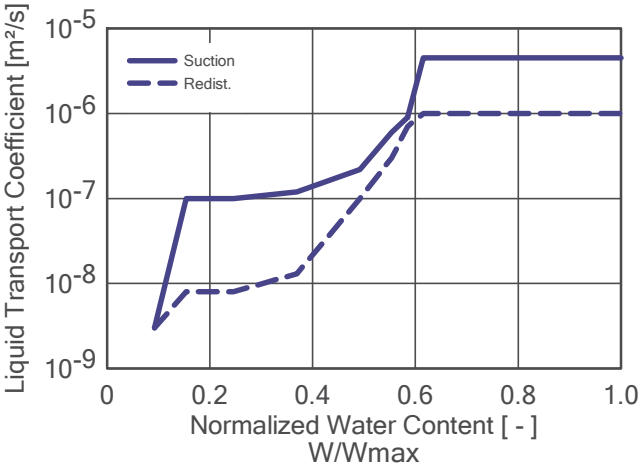


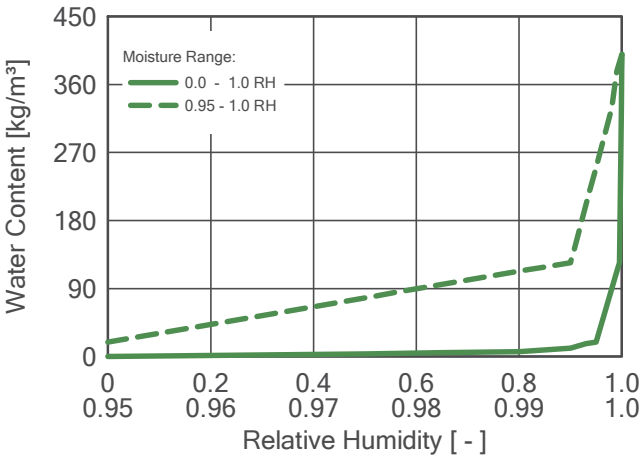
Material: Gypsum Board

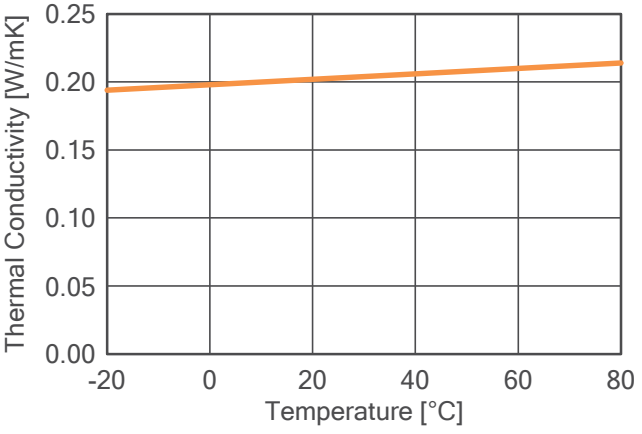
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	South / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 Medium Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 12:26:22
Computing Time	1 min,37 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -0.73
Integral of fluxes, right side (kr,dr)	[kg/m²]	3.1E-8 0.0
Balance 1	[kg/m²]	-0.61
Balance 2	[kg/m²]	-0.73

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	2.12	1.51	1.45	2.12

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.16
*ACME White EPS 100	1.79	0.65	0.18	3.09
*Smartply OSB3	92.00	73.06	69.02	92.00
*Smartply OSB3	92.00	74.37	71.52	92.00
*Smartply OSB3	92.00	74.14	72.03	94.62
*ACME EPS Silver 70	1.79	0.60	0.57	1.79
Gypsum Board	6.30	3.91	2.84	6.30

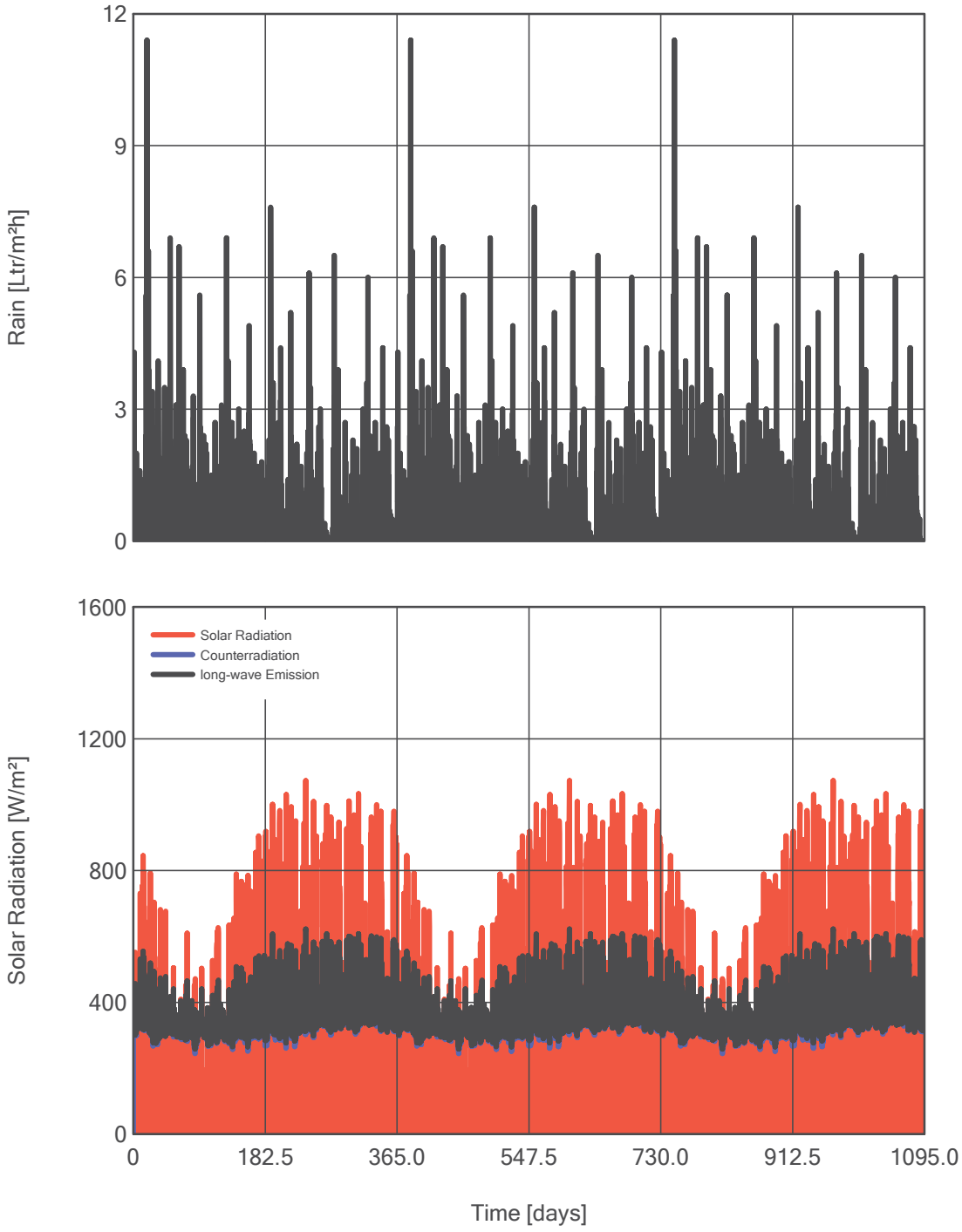
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-3878.69
Heat Flux, right side	[MJ/m²]	-96.03
Moisture Fluxes, left side	[kg/m²]	29.12
Moisture Fluxes, right side	[kg/m²]	0.0

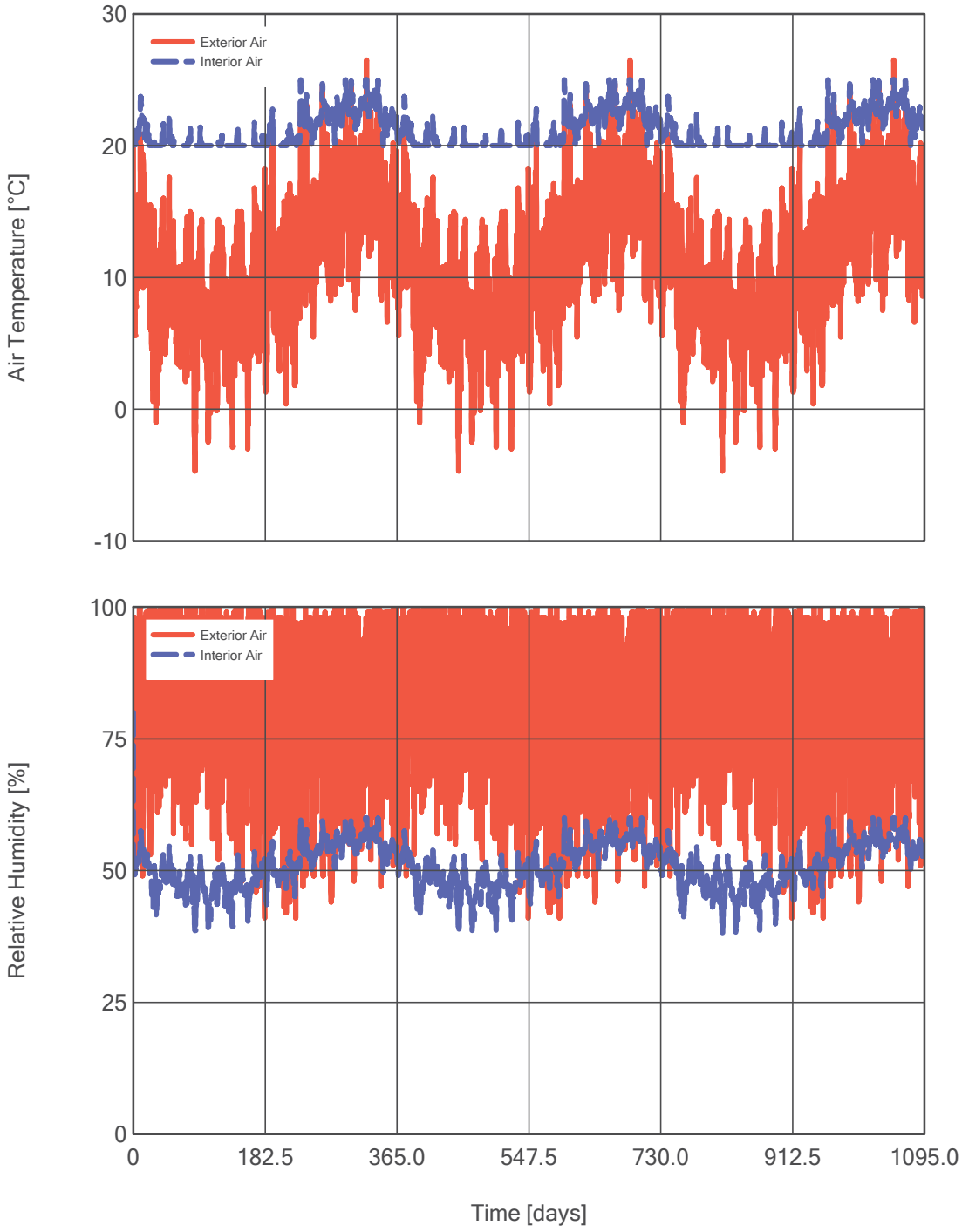
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.009
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.009

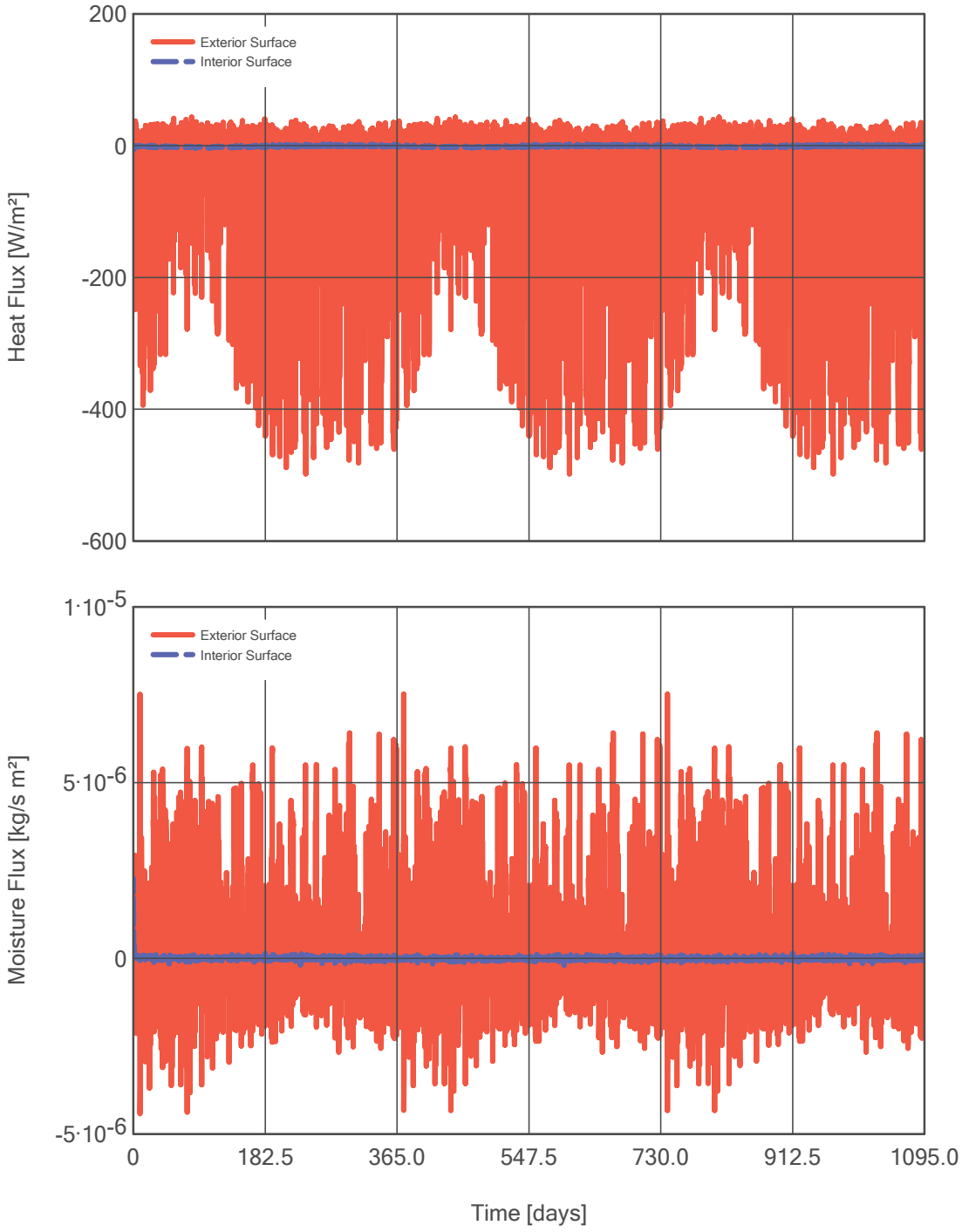
Rain, Radiation (Exterior Climate)



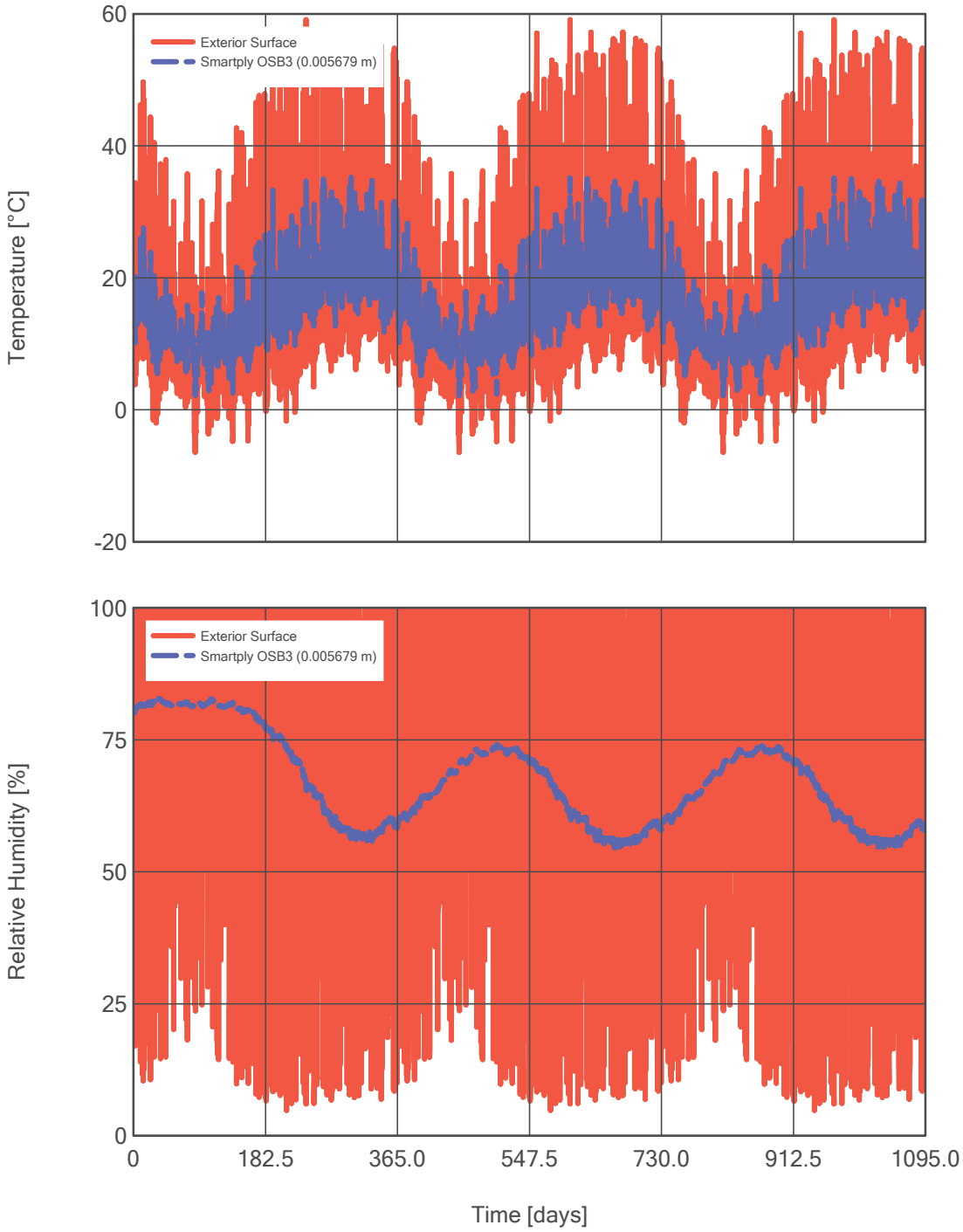
Air Temperature, RH (Exterior, Interior)



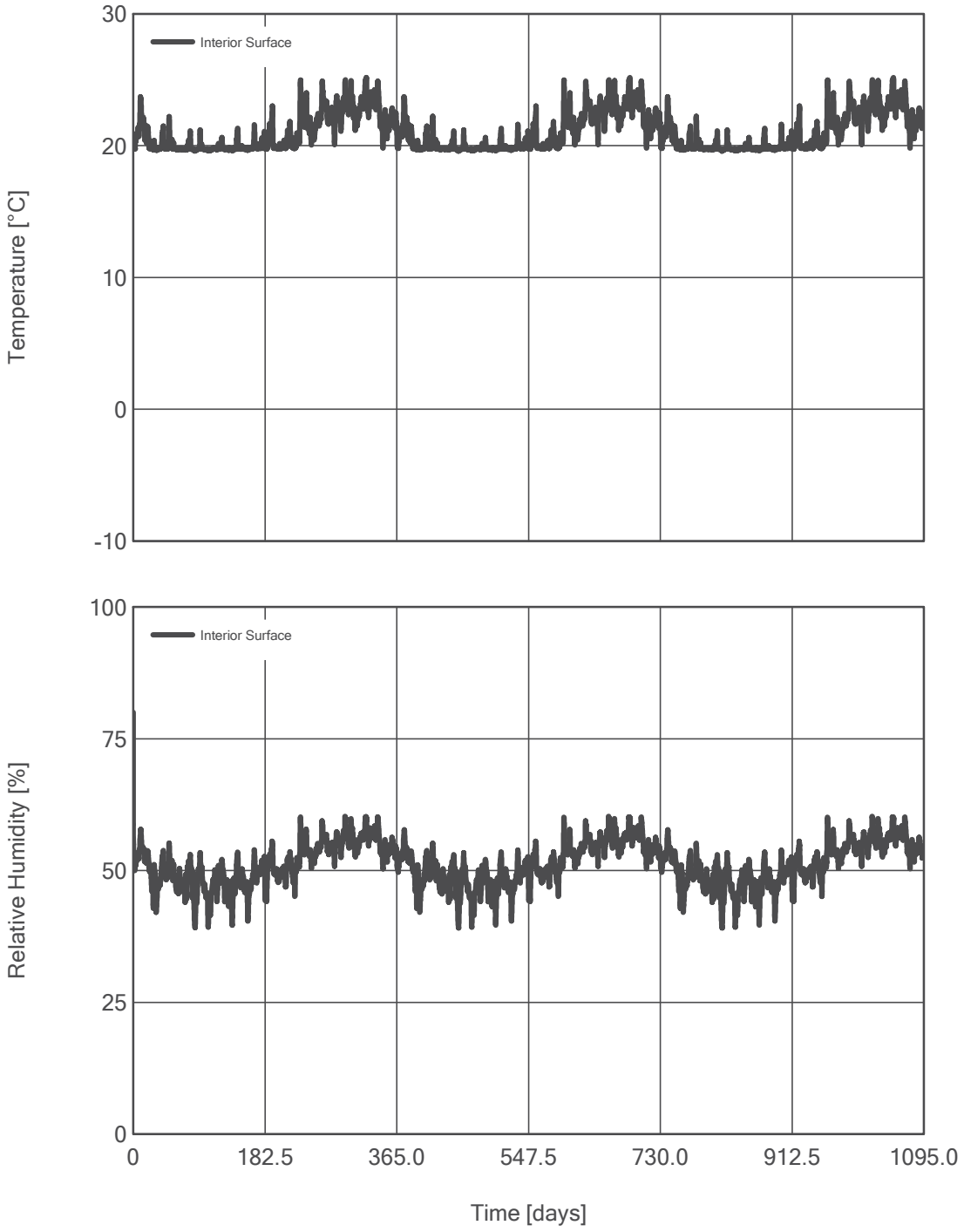
Heat, Moisture Fluxes



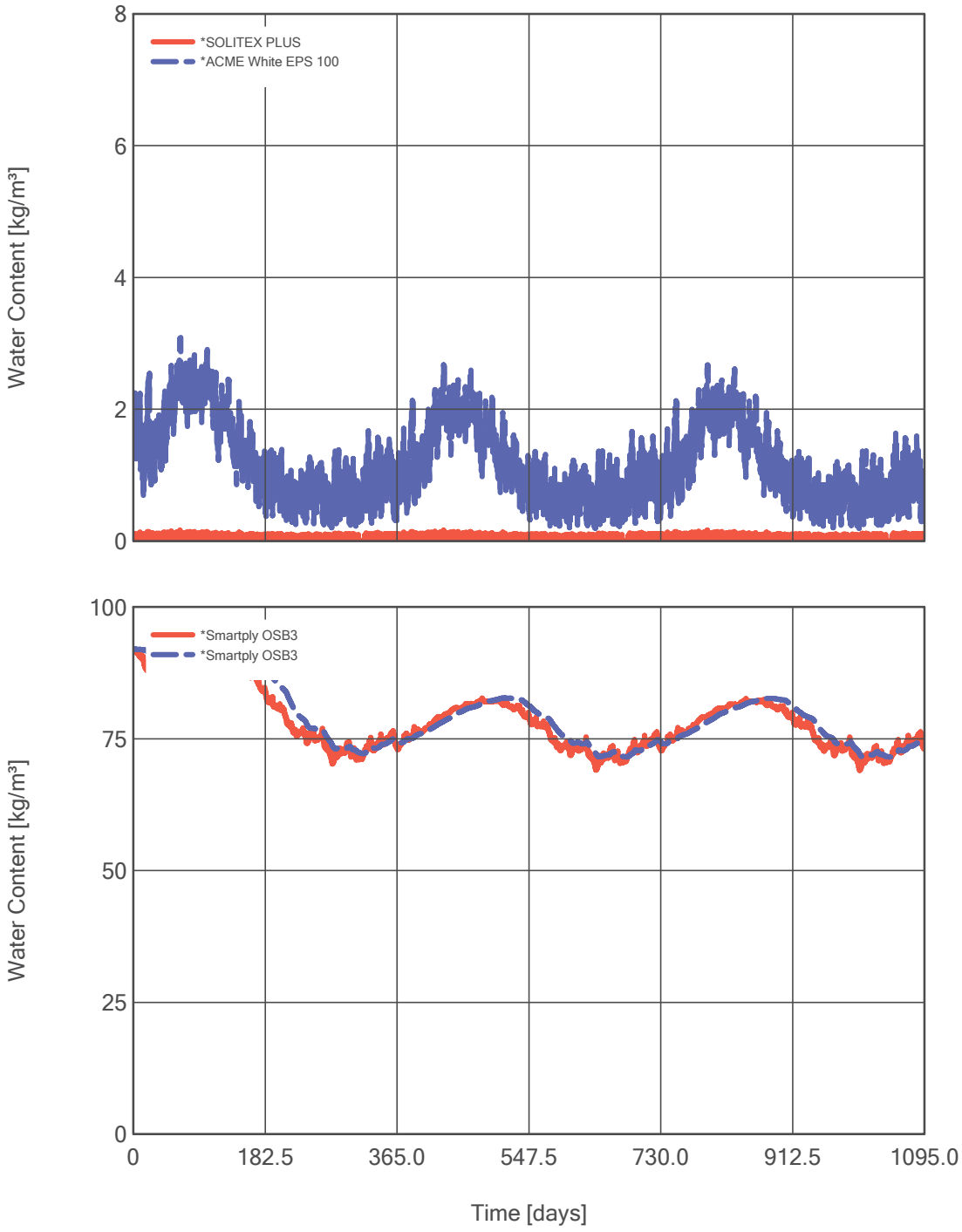
Temperature, RH (Monitor Position 1, 2)



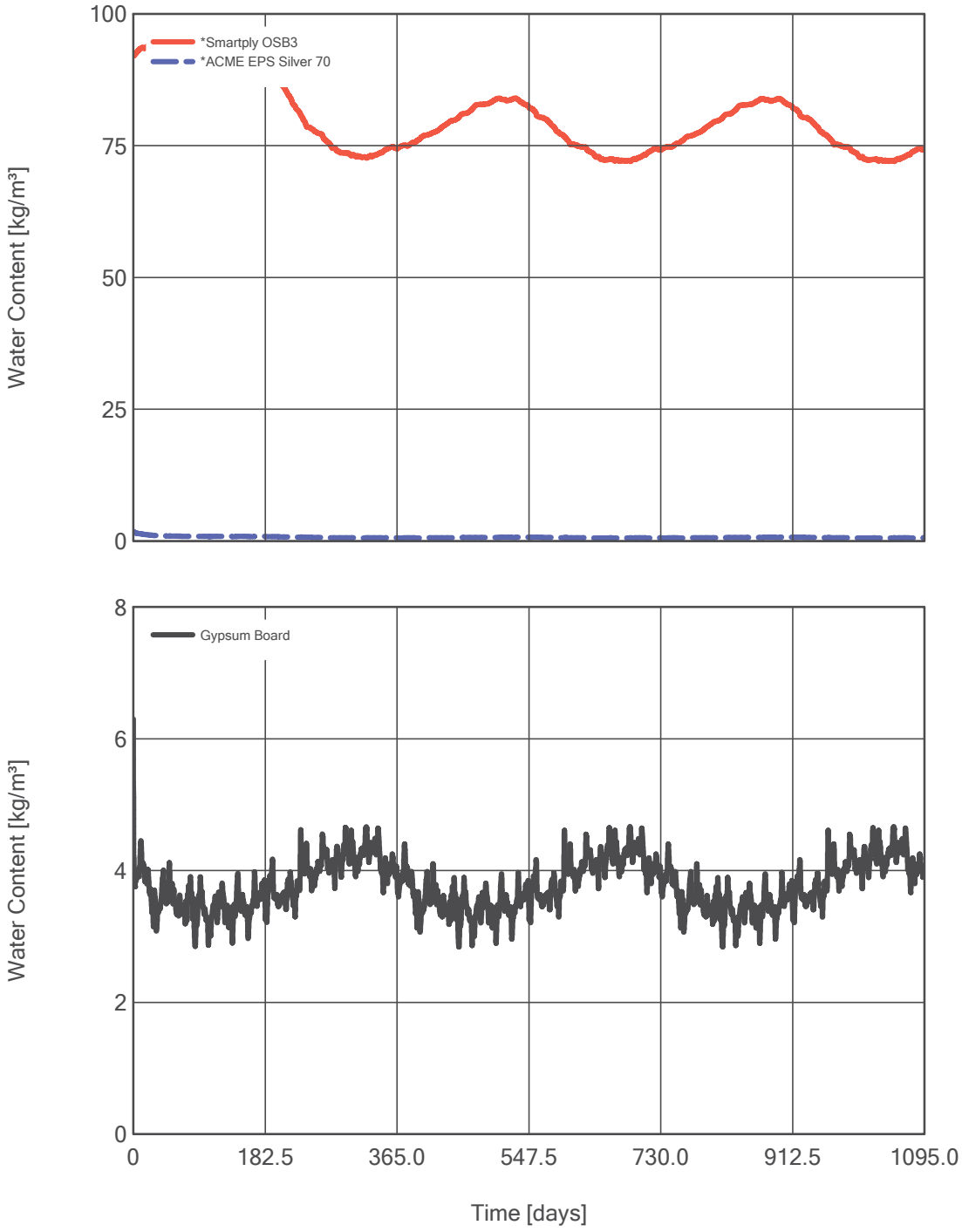
Temperature, RH (Monitor Position 3)



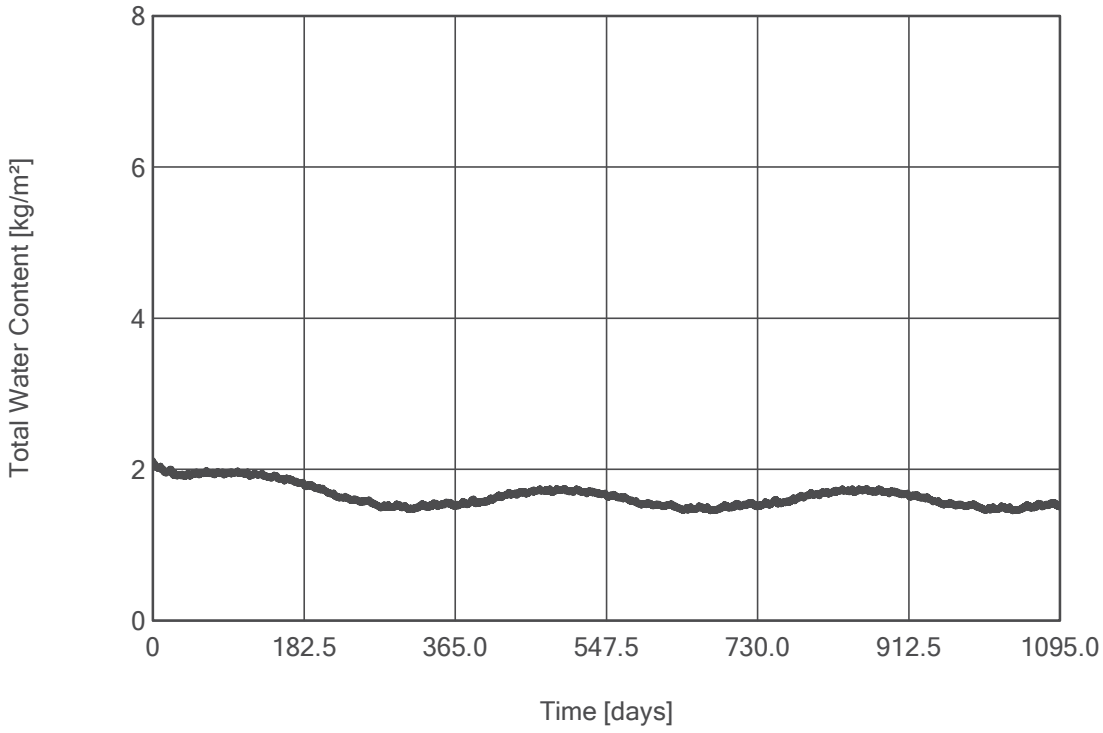
Water Content of Individual Materials



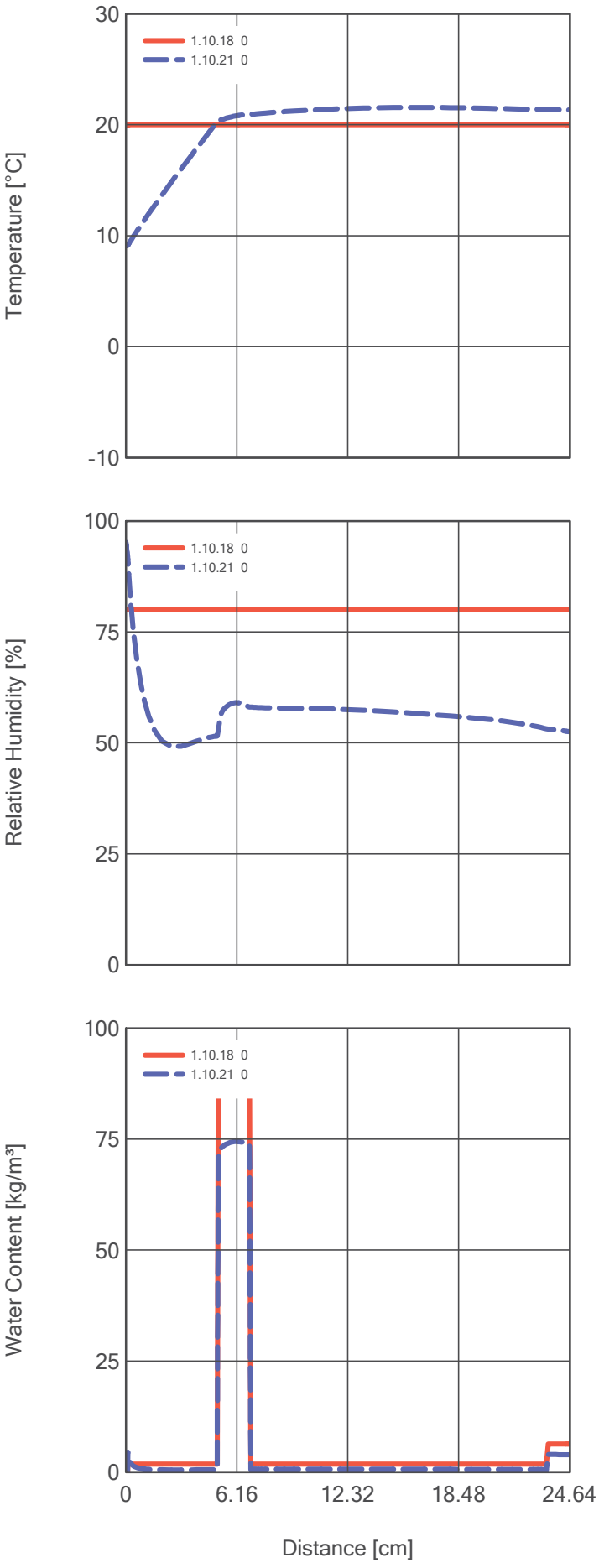
Water Content of Individual Materials



Total Water Content in Construction



Profiles

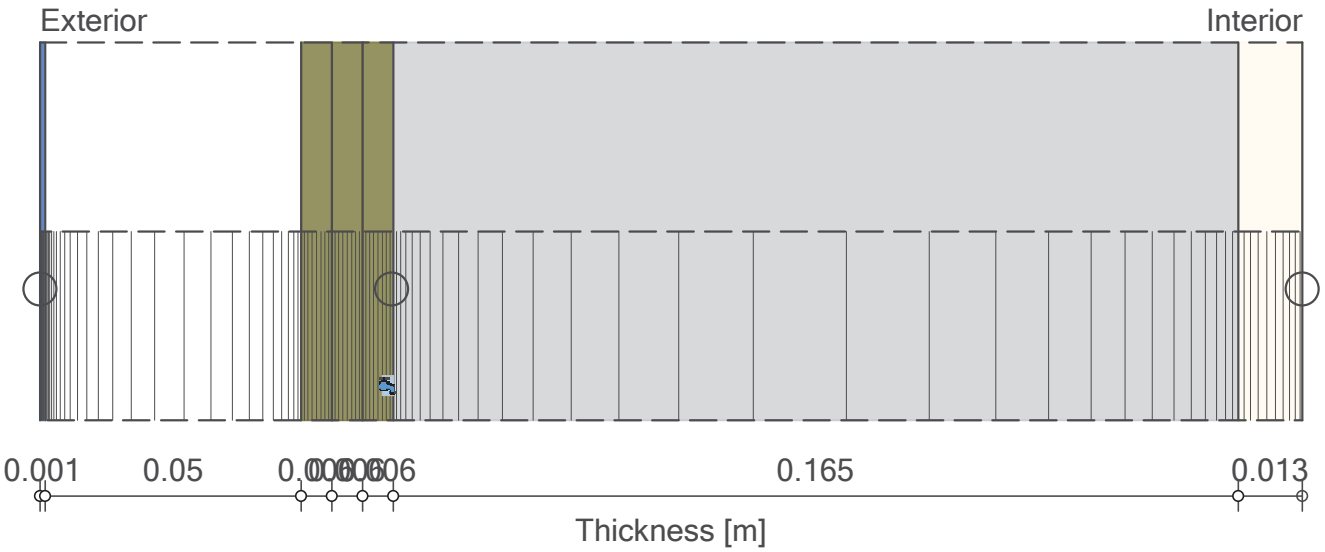

Temperature [°C]
30
20
10
0
-10
1.10.18 0
1.10.21 0
Relative Humidity [%]
100
75
50
25
0
1.10.18 0
1.10.21 0
Water Content [kg/m³]
100
75
50
25
0
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #3 North Pitched Roof with high moisture load & 10ACH



- Monitor positions

- Heat/Moisture source/sink positions

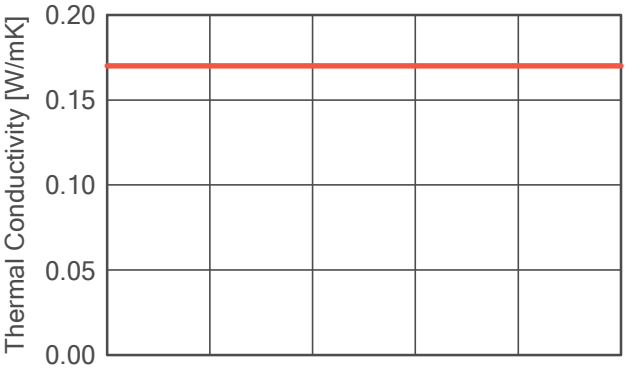
Materials:

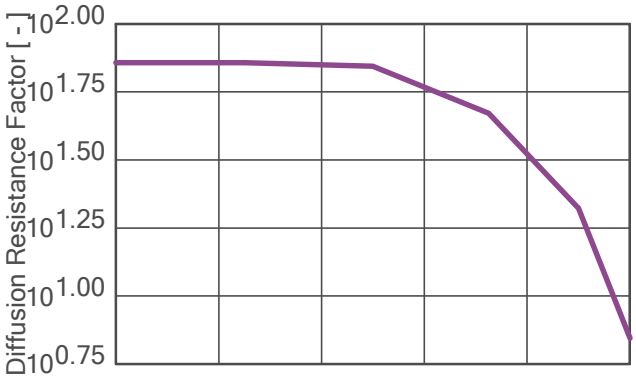
- *SOLITEX PLUS	0.001 m
- *ACME White EPS 100	0.05 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *ACME EPS Silver 70	0.165 m
- Gypsum Board	0.013 m

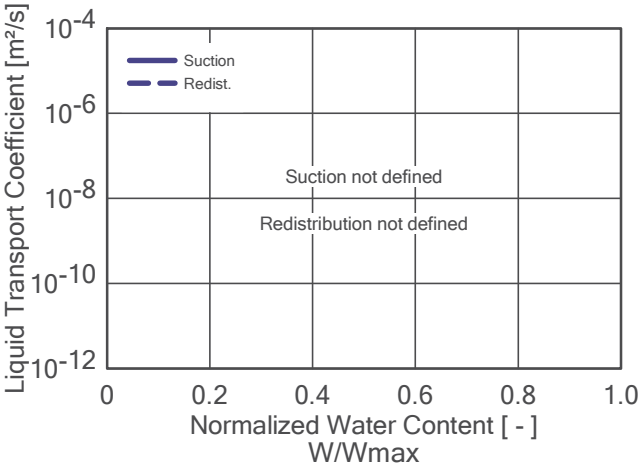
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

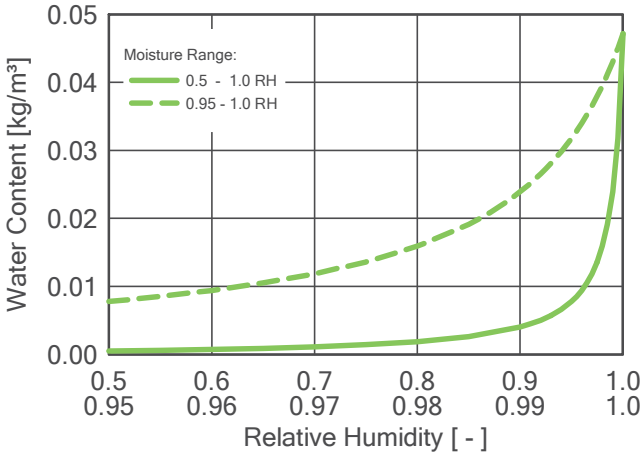
Material: *SOLITEX PLUS

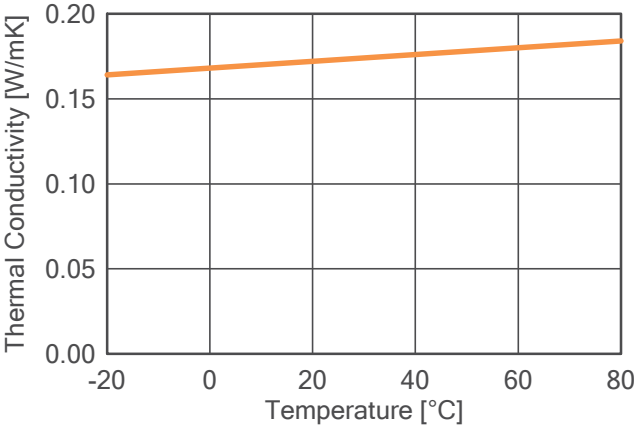
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





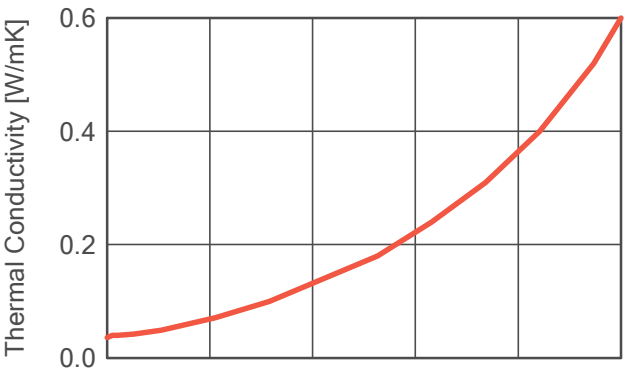


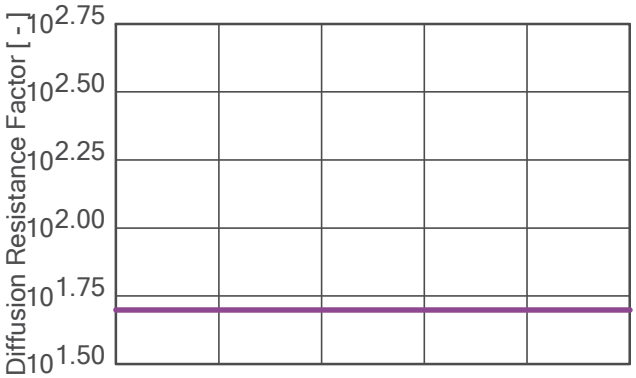


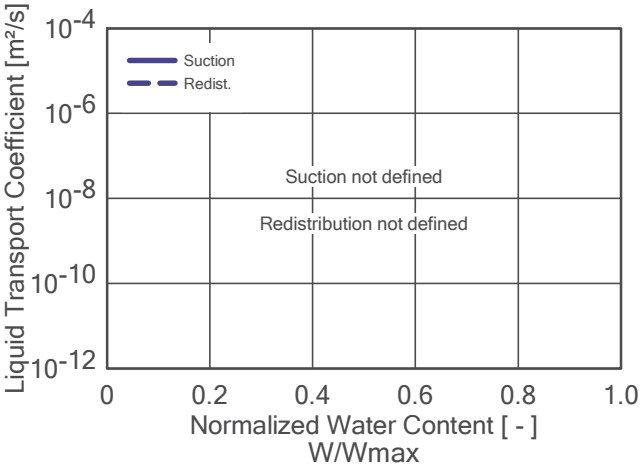


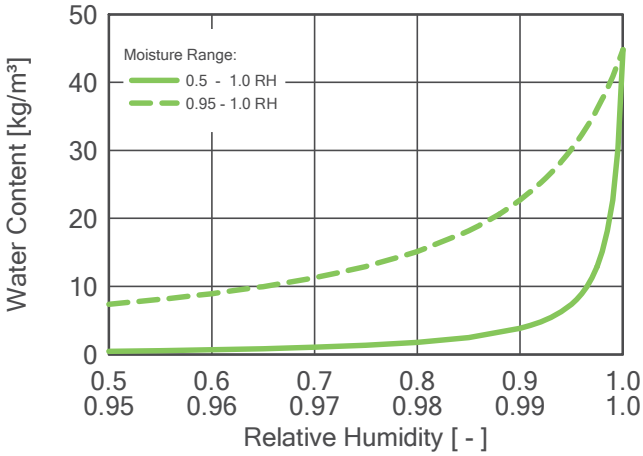
Material: *ACME White EPS 100

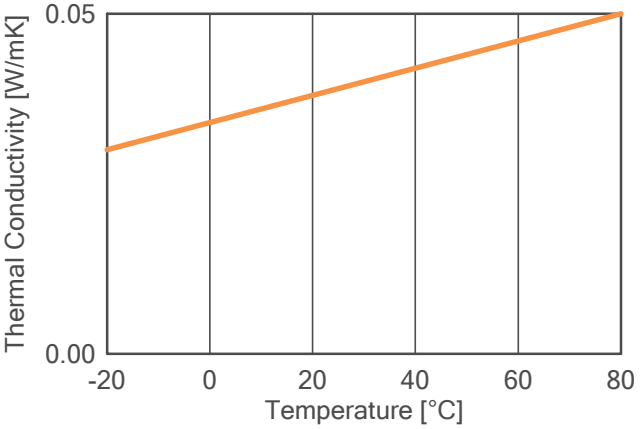
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





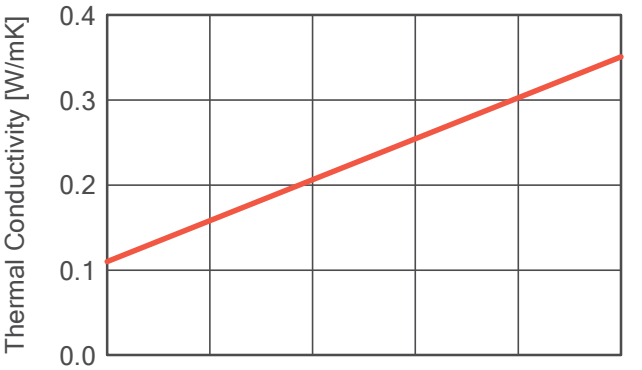


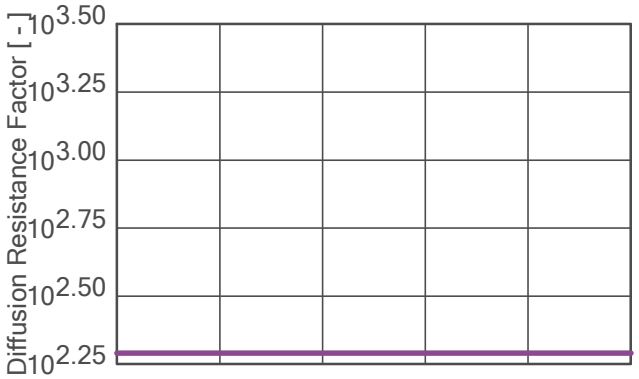


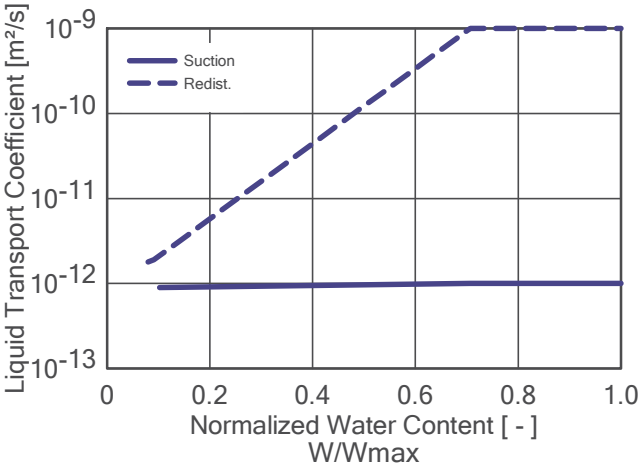


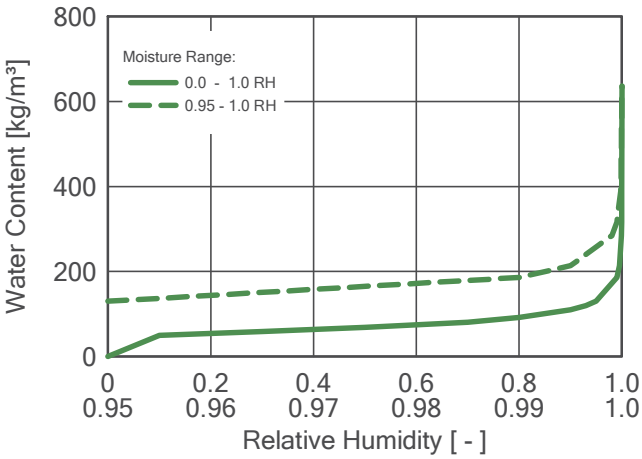
Material: *Smartply OSB3

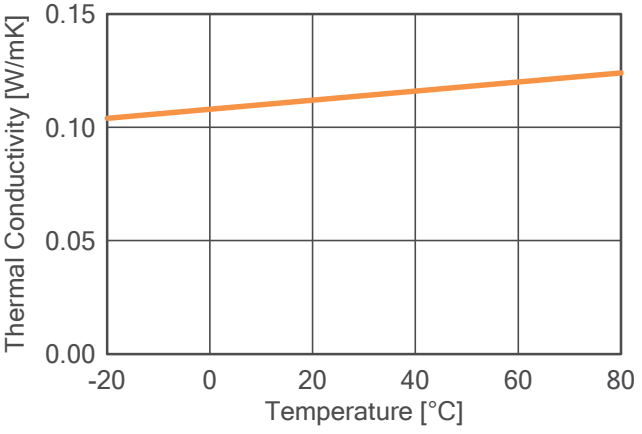
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





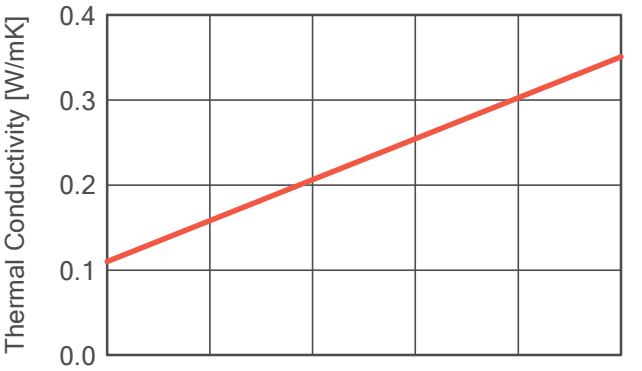


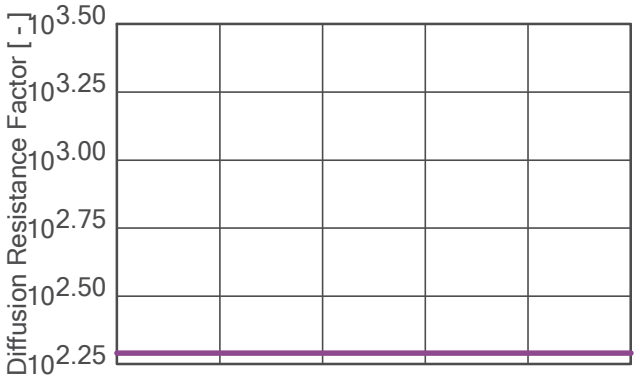


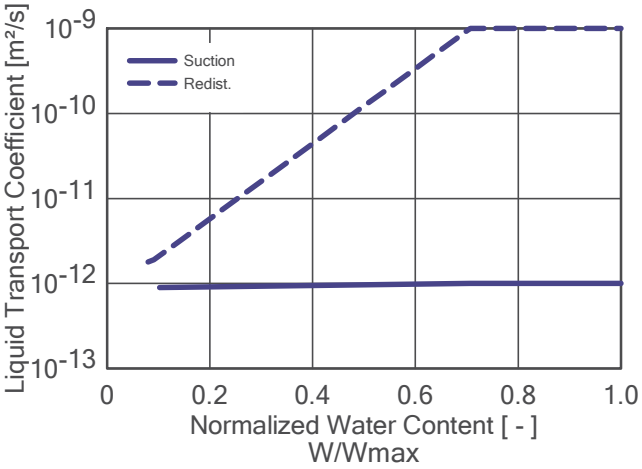


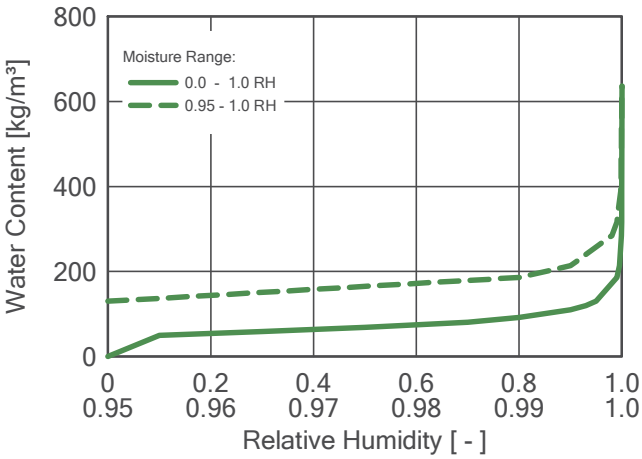
Material: *Smartply OSB3

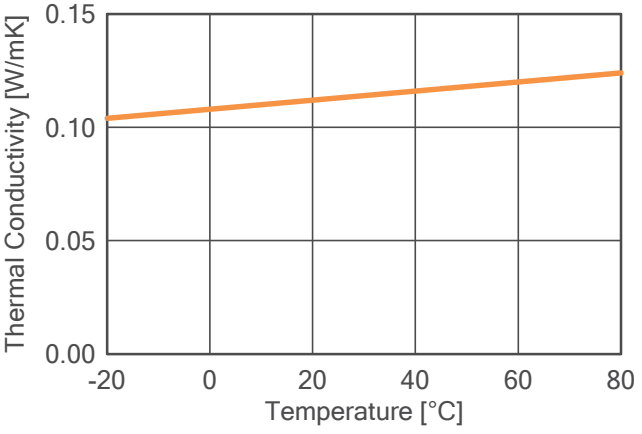
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





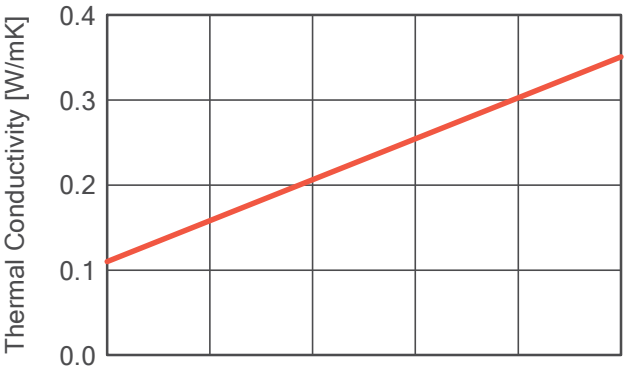


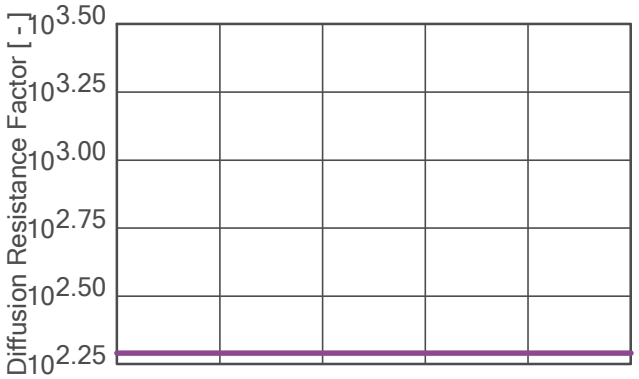


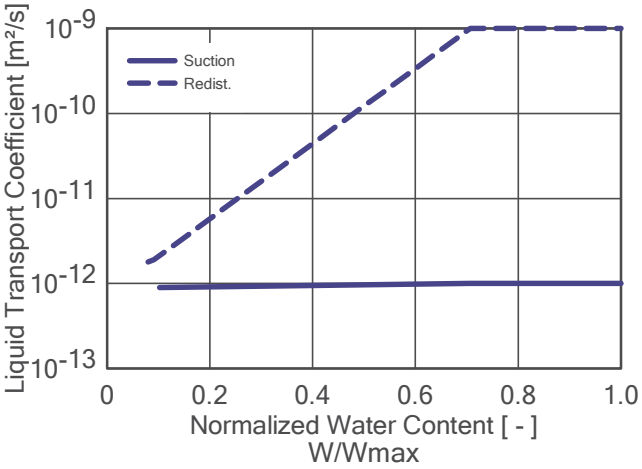


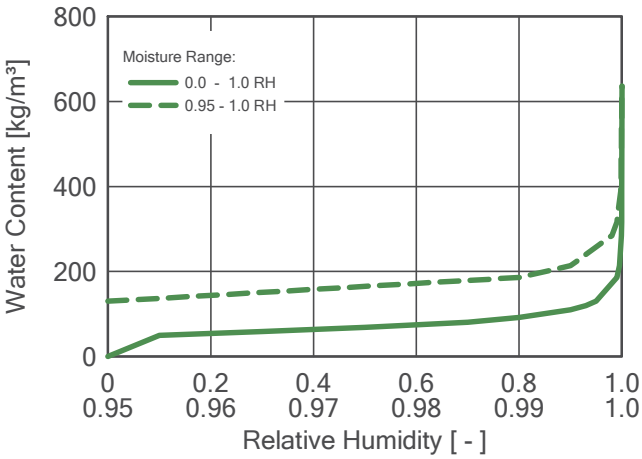
Material: *Smartply OSB3

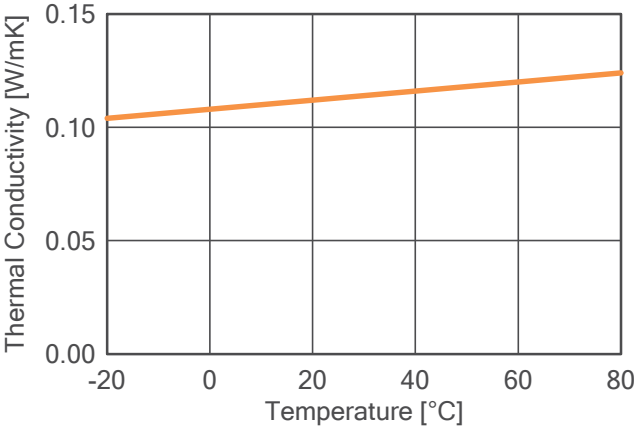
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





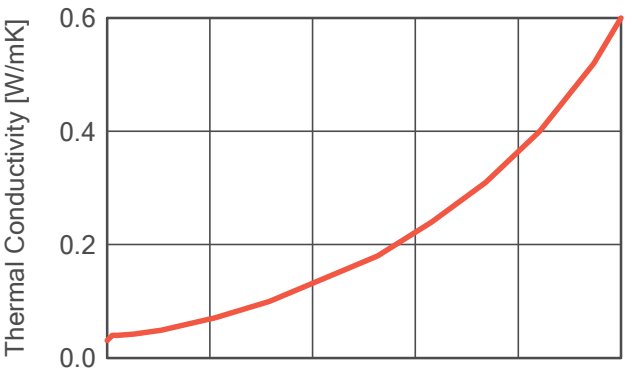


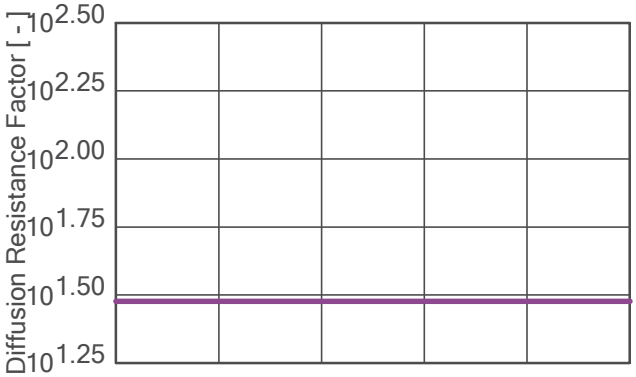


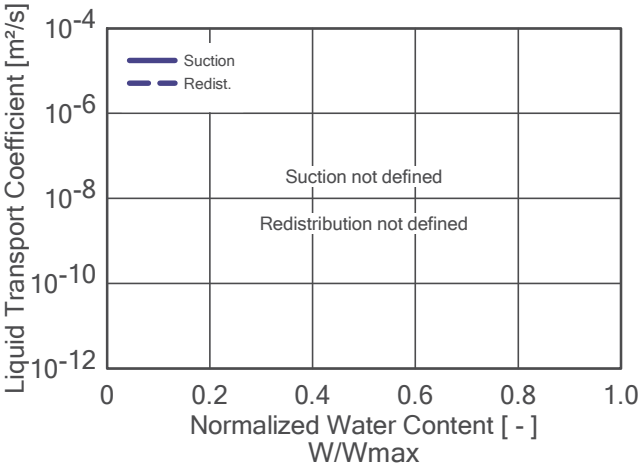


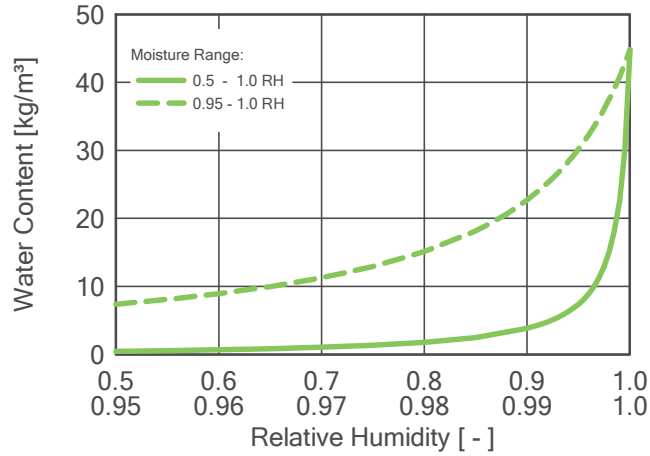
Material: *ACME EPS Silver 70

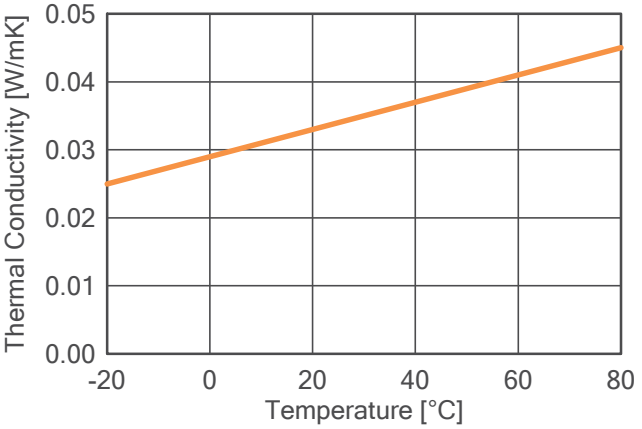
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





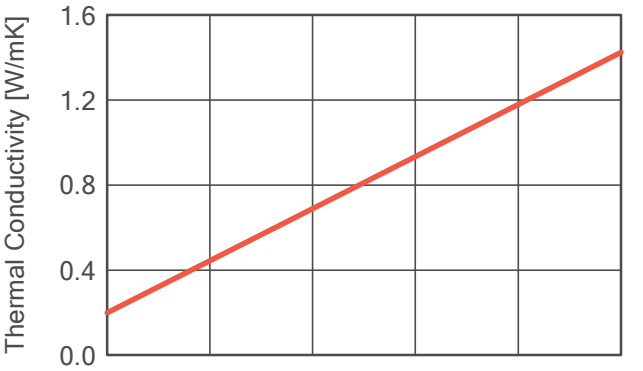


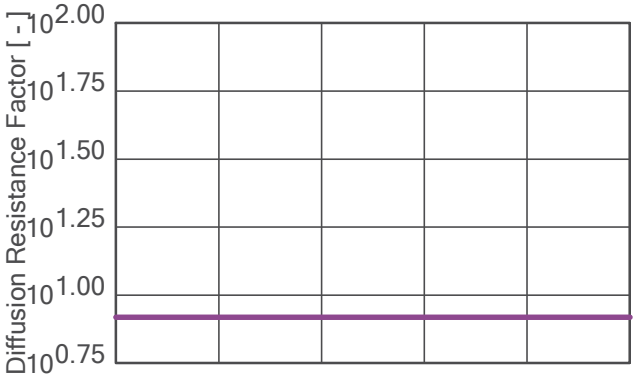


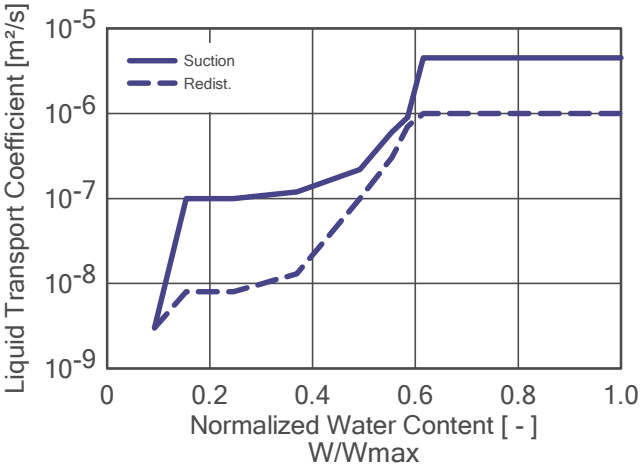


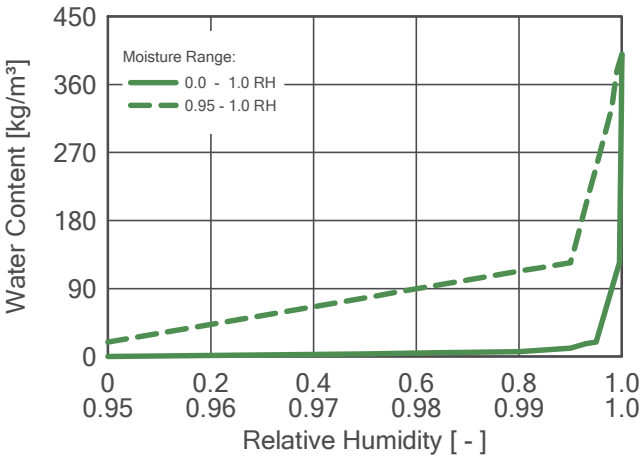
Material: Gypsum Board

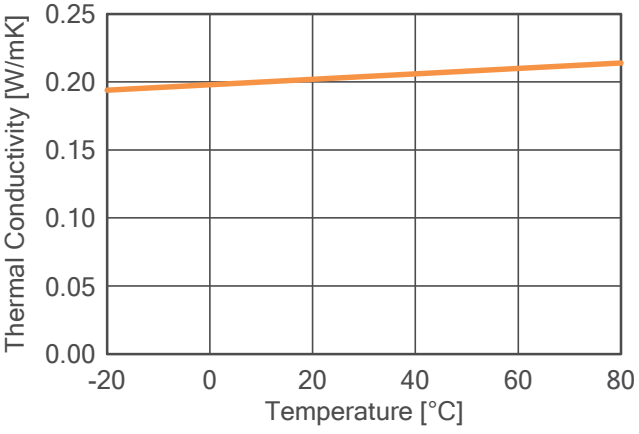
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	North / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 High Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 12:28:02
Computing Time	1 min,37 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -1.07
Integral of fluxes, right side (kr,dr)	[kg/m²]	4.9E-8 -0.51
Balance 1	[kg/m²]	-0.32
Balance 2	[kg/m²]	-0.35

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	2.12	1.8	1.7	2.23

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.18
*ACME White EPS 100	1.79	1.76	0.35	3.73
*Smartply OSB3	92.00	81.58	76.99	93.69
*Smartply OSB3	92.00	81.79	79.64	99.72
*Smartply OSB3	92.00	83.61	80.87	106.67
*ACME EPS Silver 70	1.79	1.02	0.99	1.79
Gypsum Board	6.30	5.05	3.60	6.30

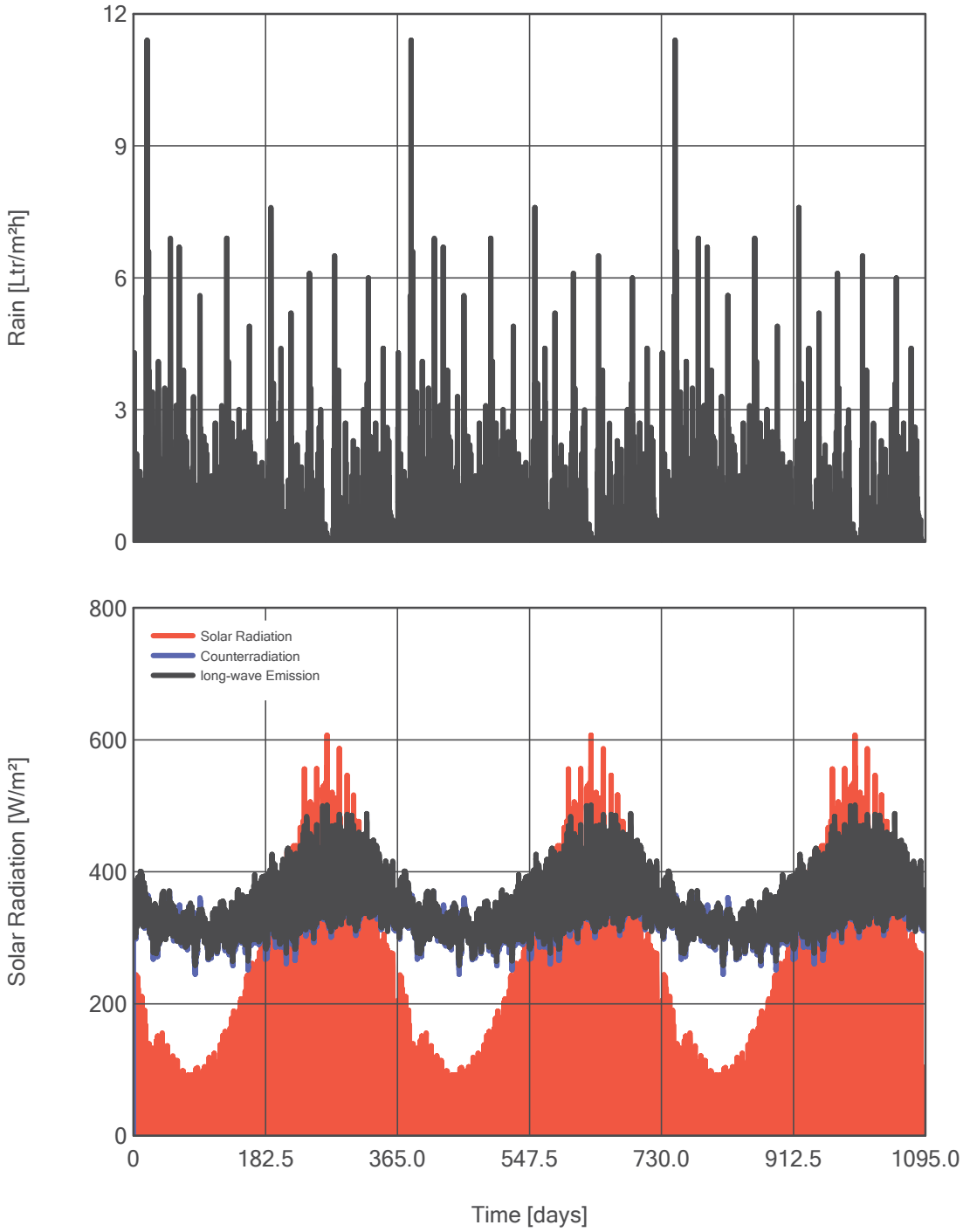
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-1727.19
Heat Flux, right side	[MJ/m²]	-124.69
Moisture Fluxes, left side	[kg/m²]	30.86
Moisture Fluxes, right side	[kg/m²]	-0.51

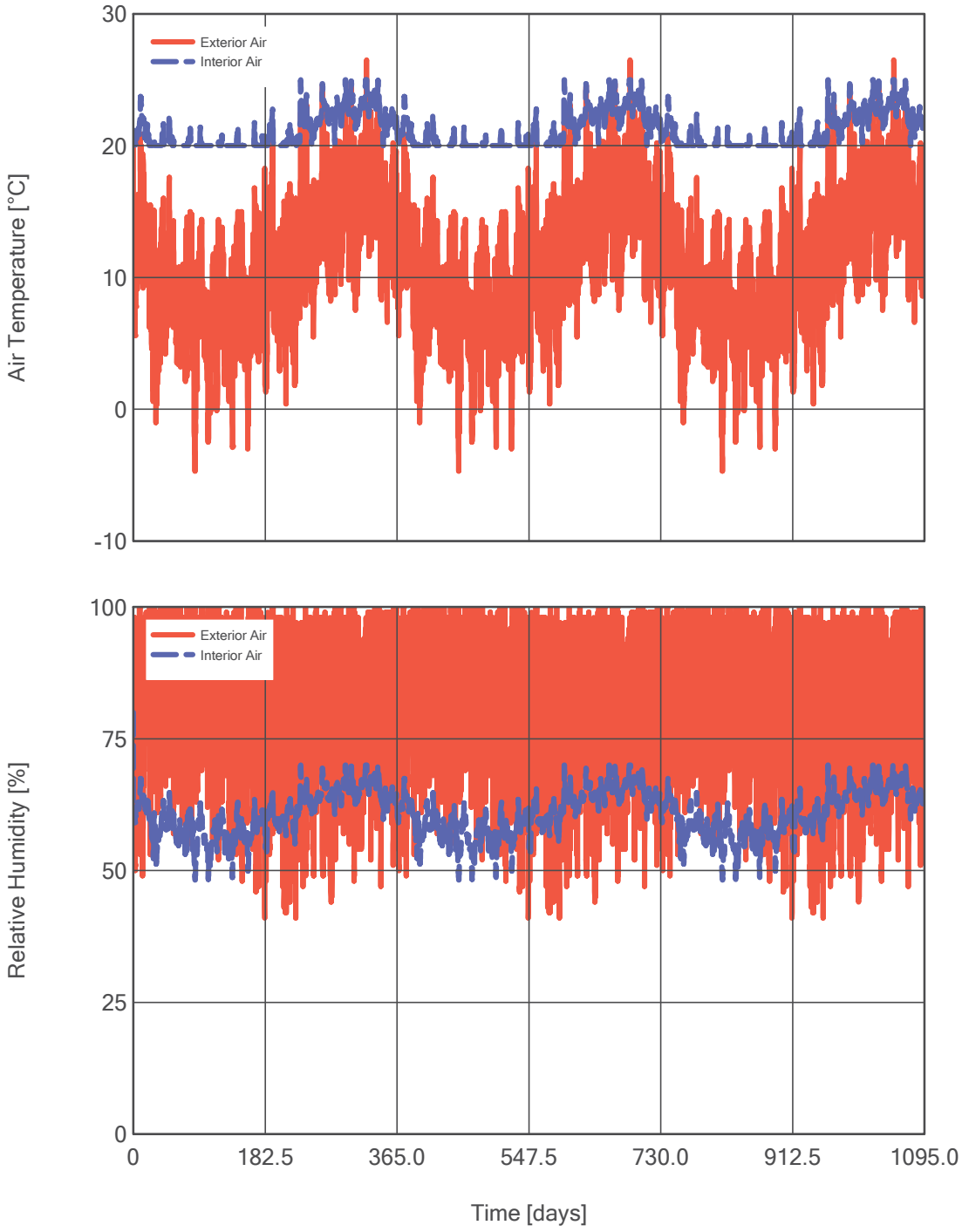
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.21
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.21

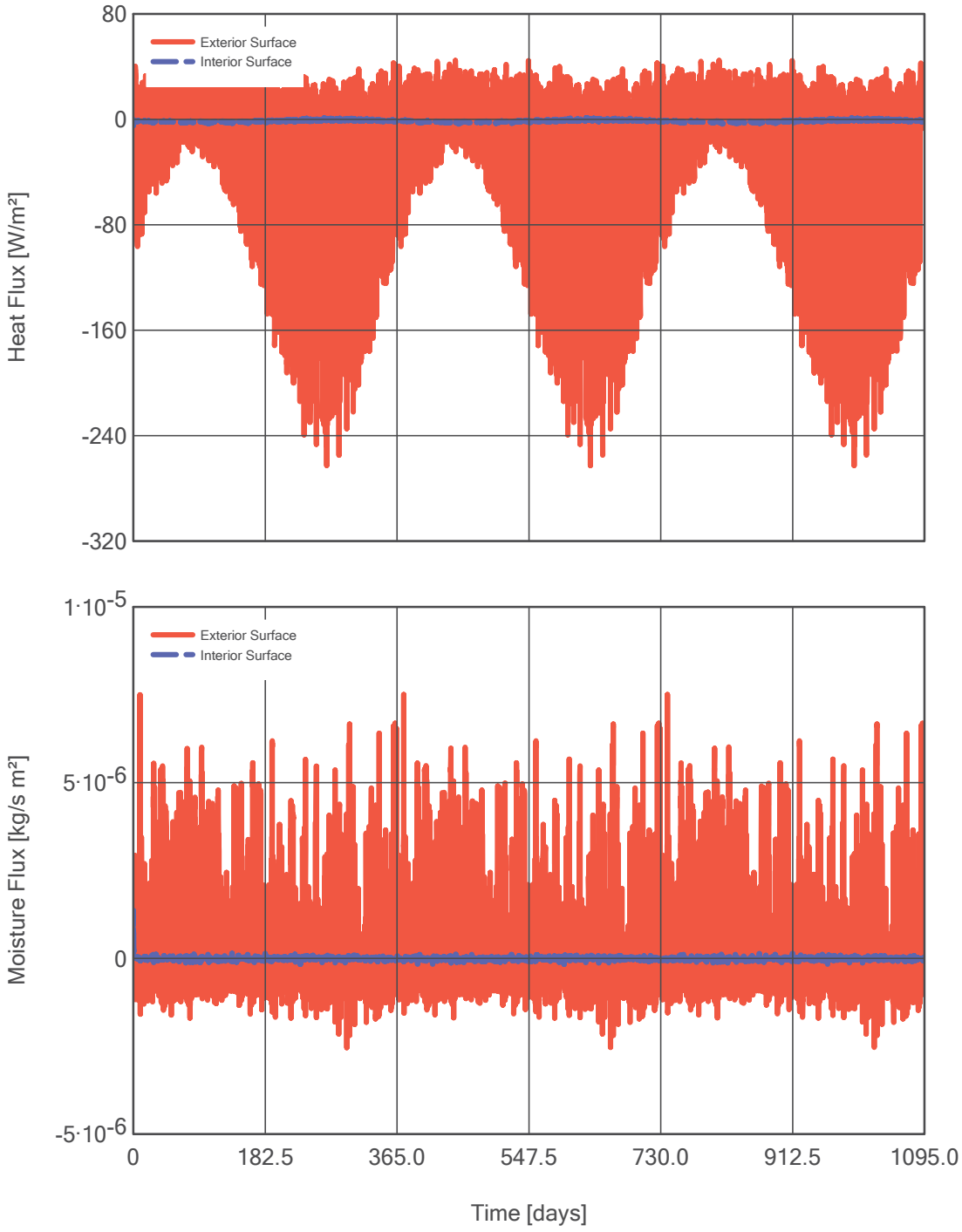
Rain, Radiation (Exterior Climate)



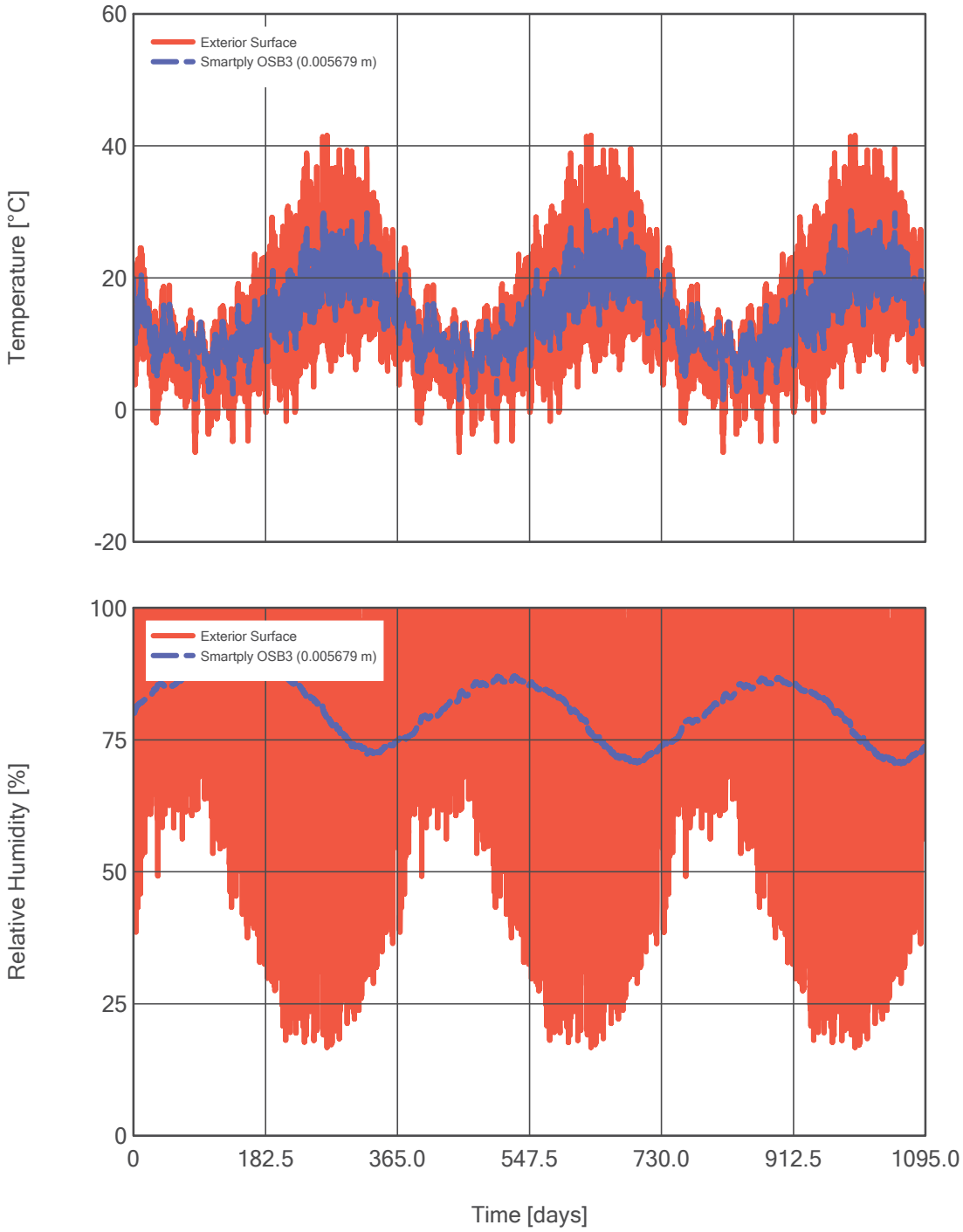
Air Temperature, RH (Exterior, Interior)



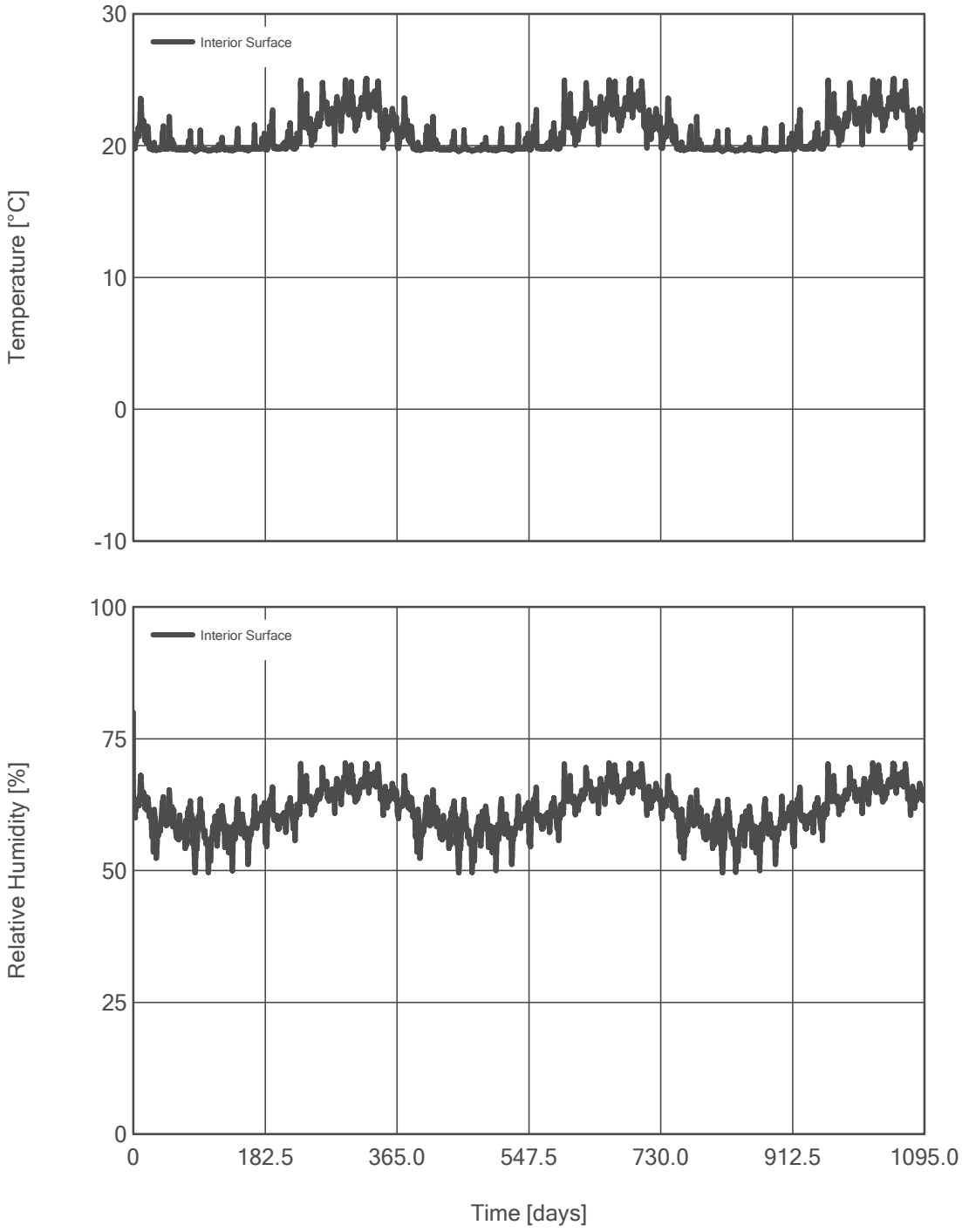
Heat, Moisture Fluxes



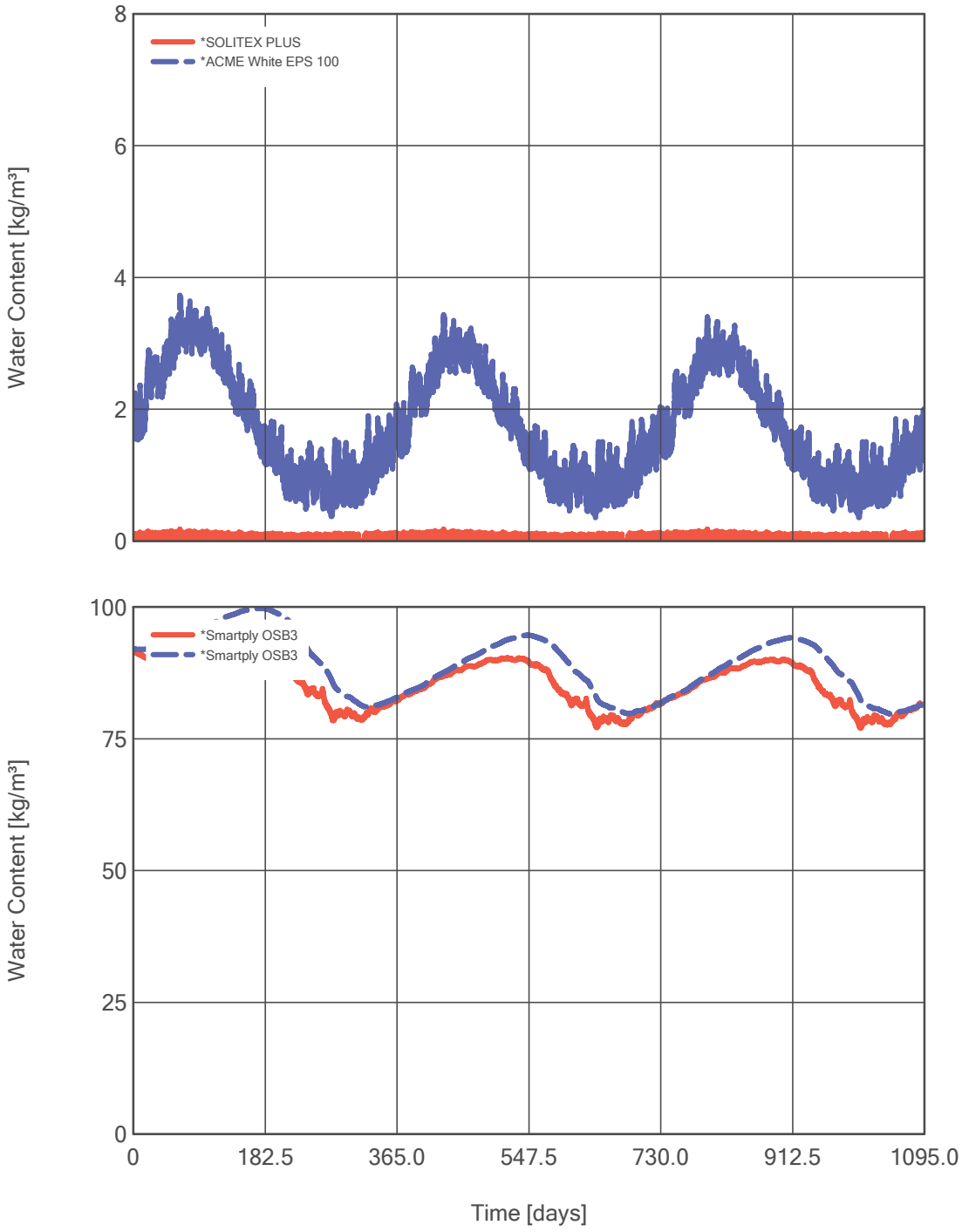
Temperature, RH (Monitor Position 1, 2)



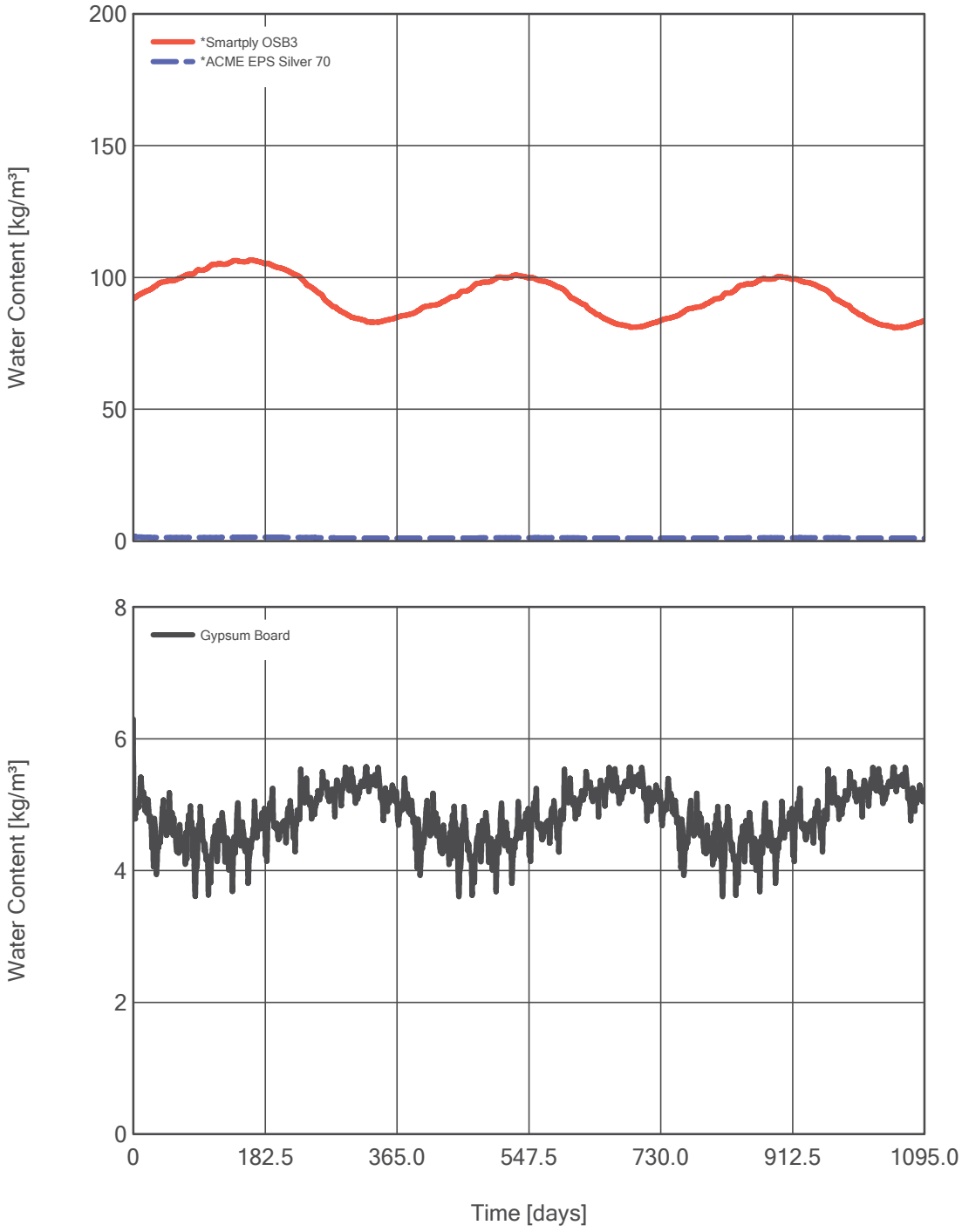
Temperature, RH (Monitor Position 3)



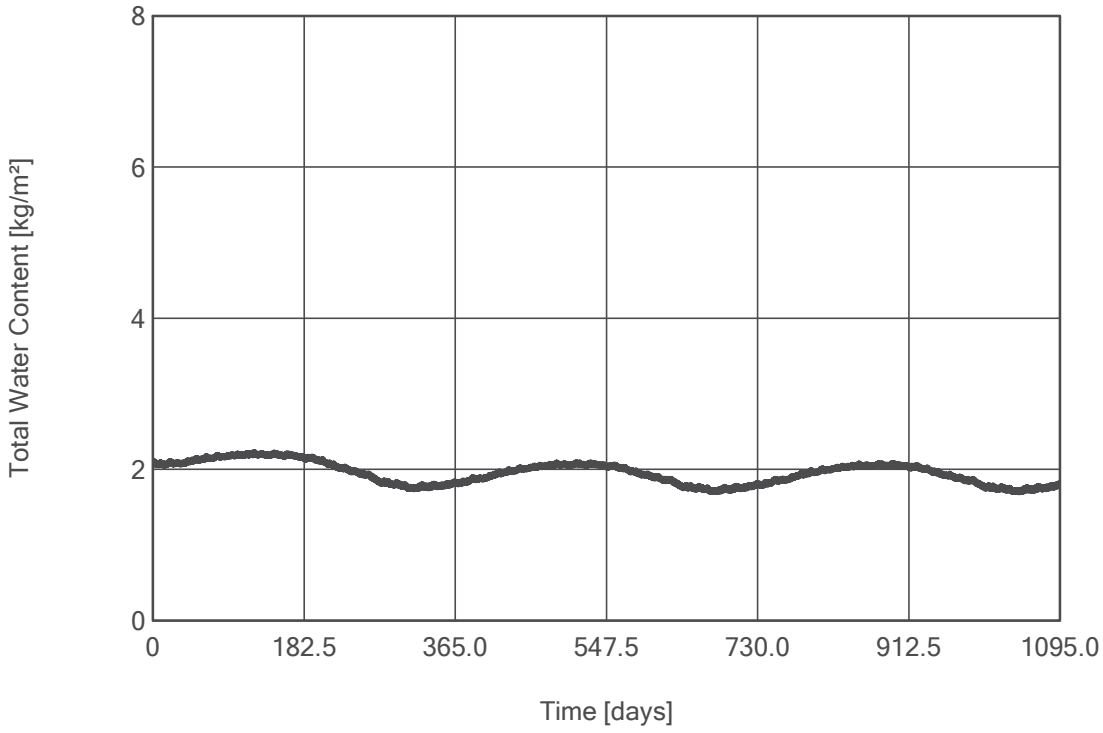
Water Content of Individual Materials



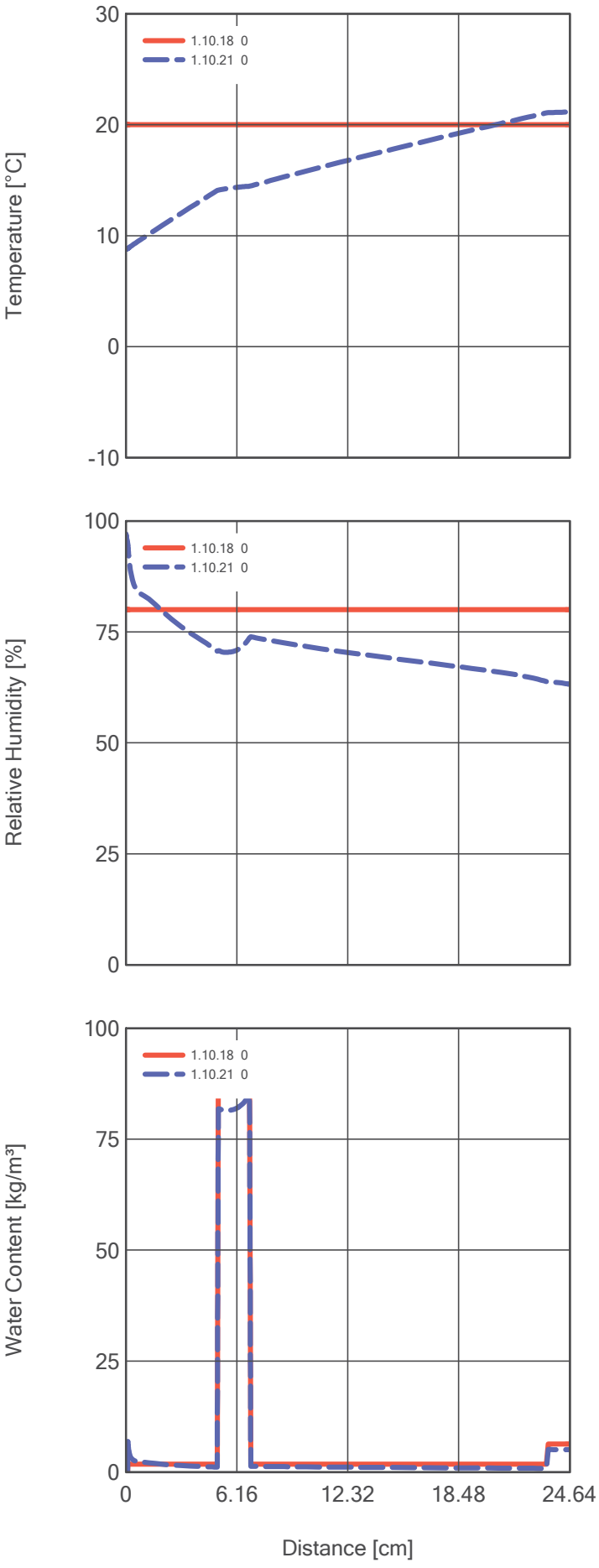
Water Content of Individual Materials



Total Water Content in Construction



Profiles

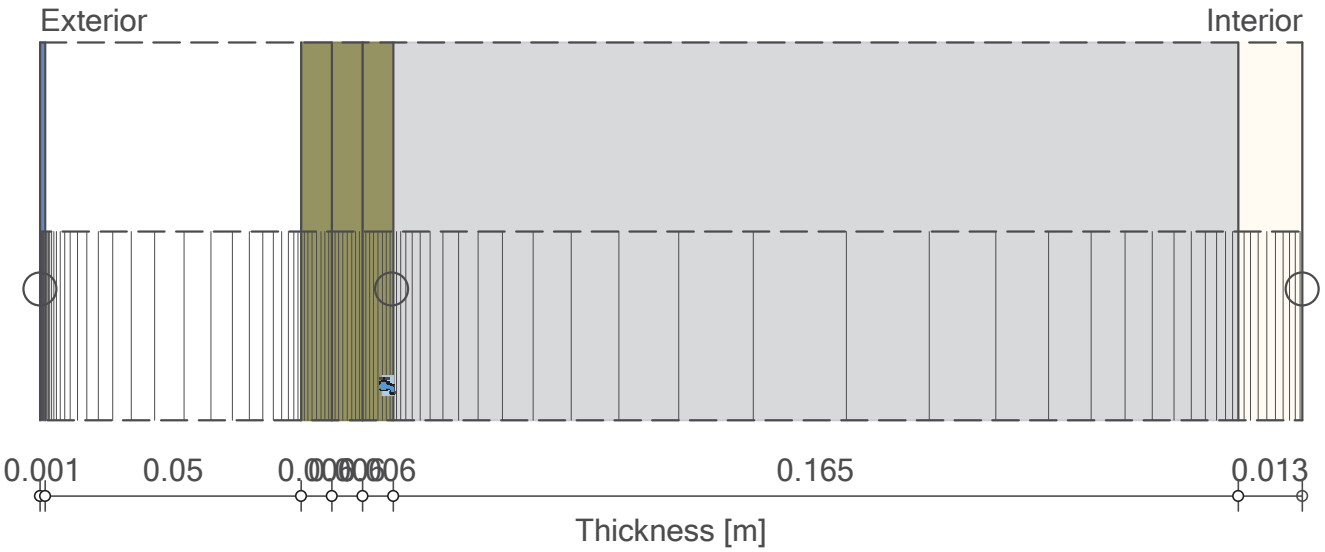

30
20
10
0
-10
Temperature [°C]
1.10.18 0
1.10.21 0
100
75
50
25
0
Relative Humidity [%]
1.10.18 0
1.10.21 0
100
75
50
25
0
Water Content [kg/m³]
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #4 South Pitched Roof with high internal moisture load &10ACH



- Monitor positions

- Heat/Moisture source/sink positions

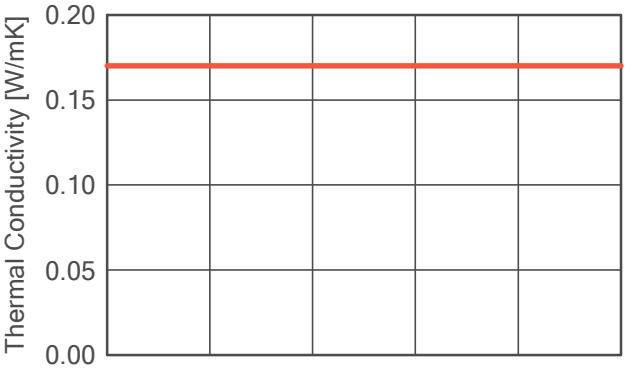
Materials:

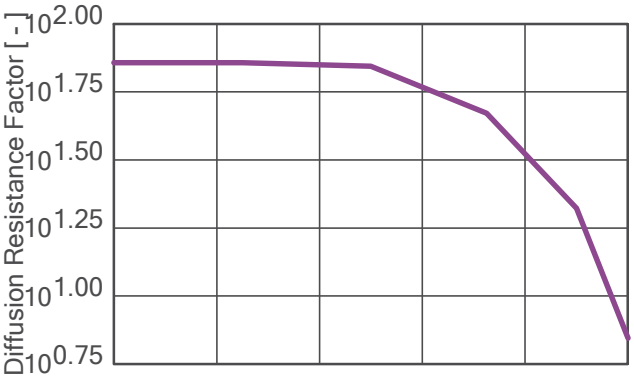
	- *SOLITEX PLUS	0.001 m
	- *ACME White EPS 100	0.05 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *ACME EPS Silver 70	0.165 m
	- Gypsum Board	0.013 m

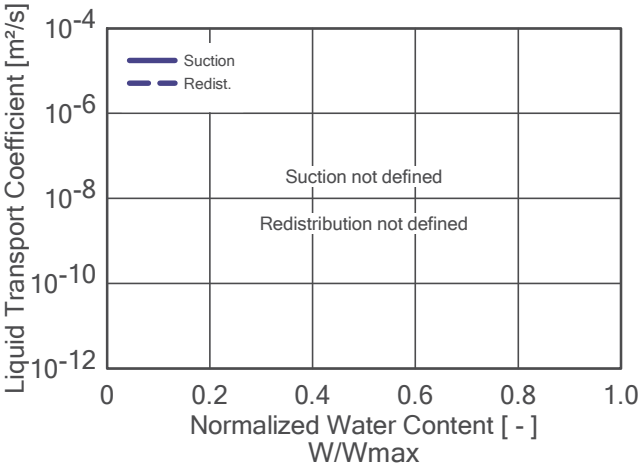
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

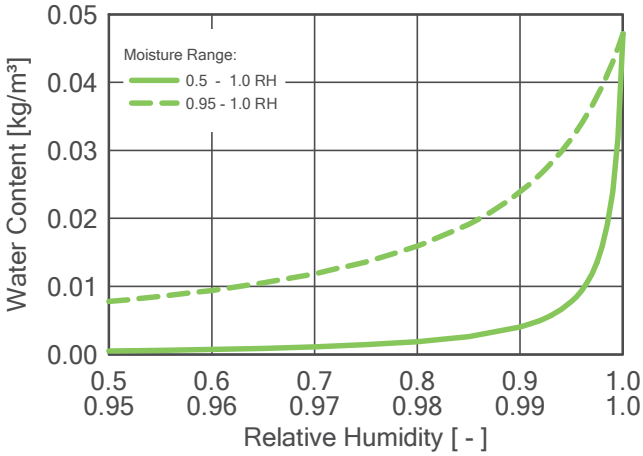
Material: *SOLITEX PLUS

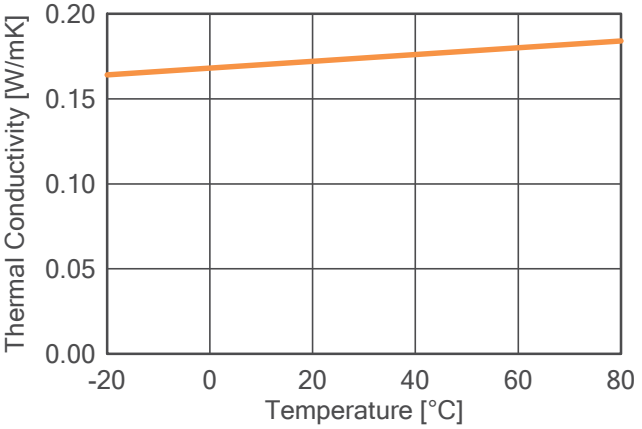
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





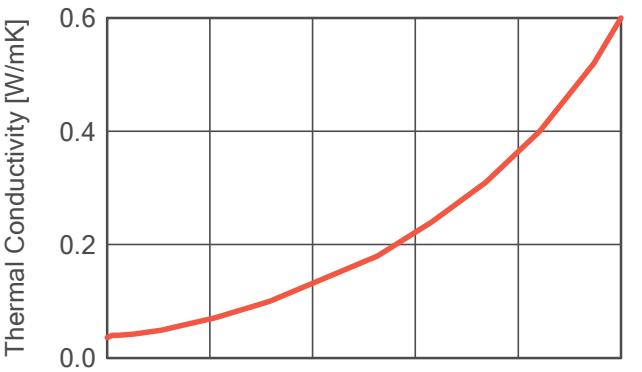


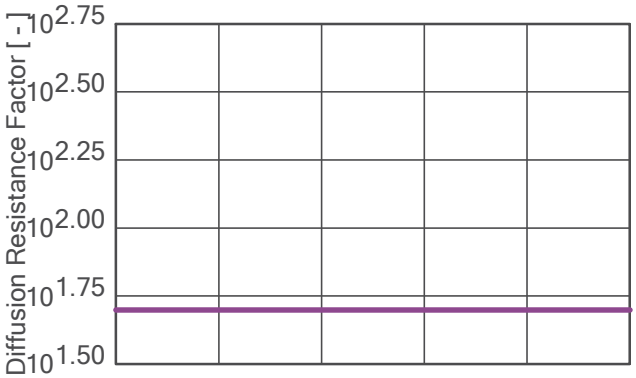


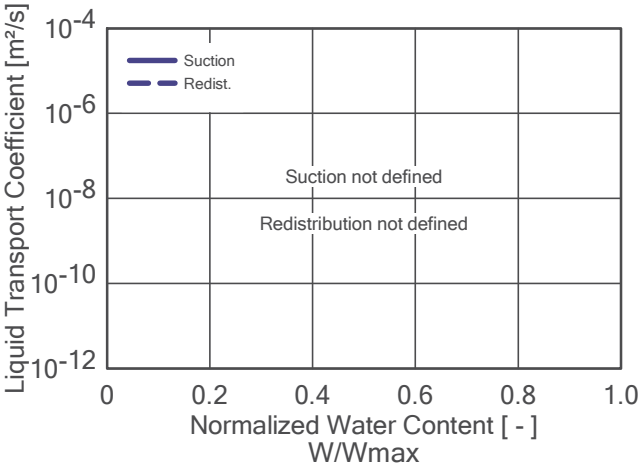


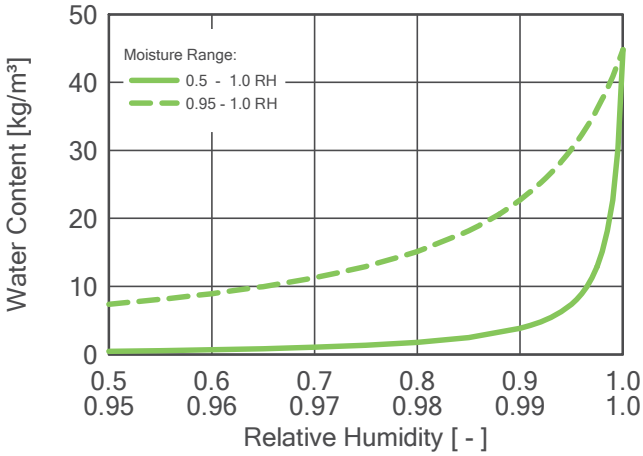
Material: *ACME White EPS 100

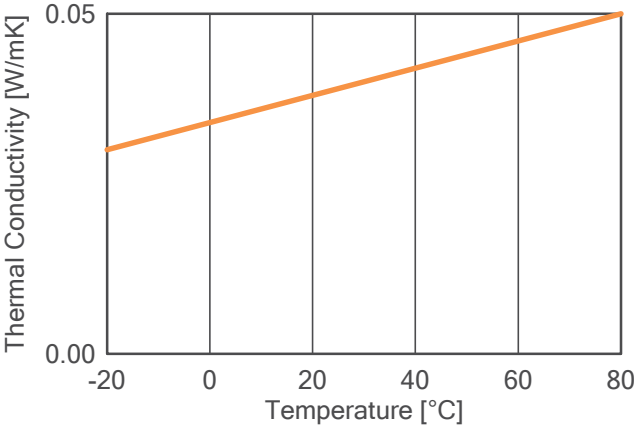
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





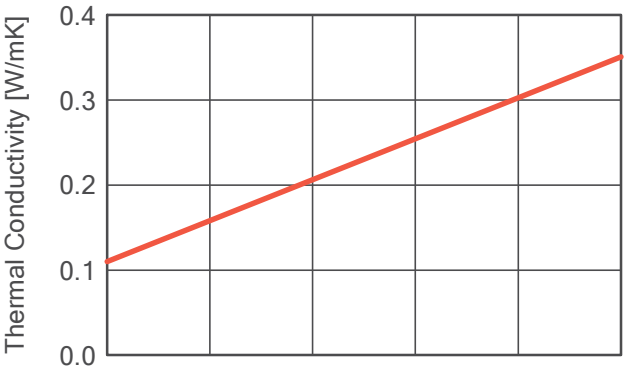


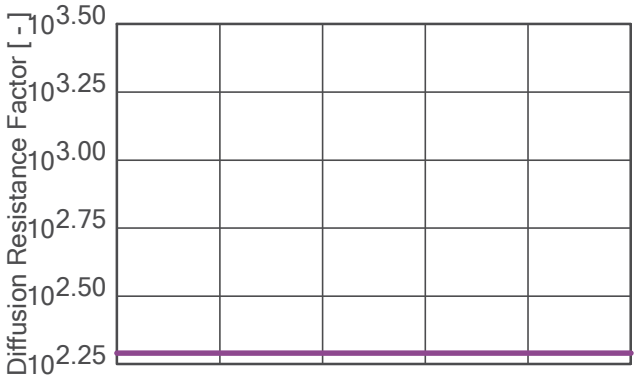


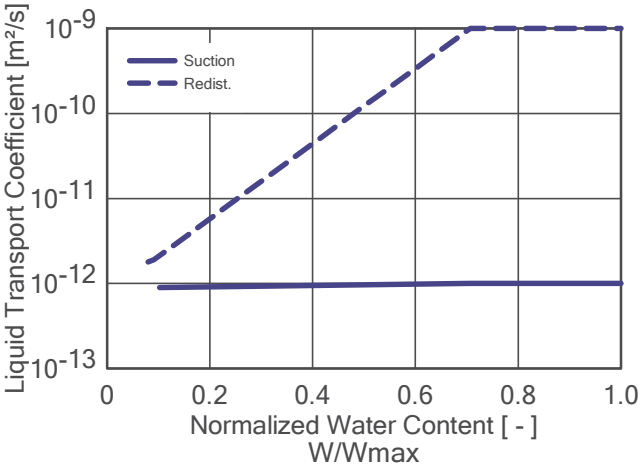


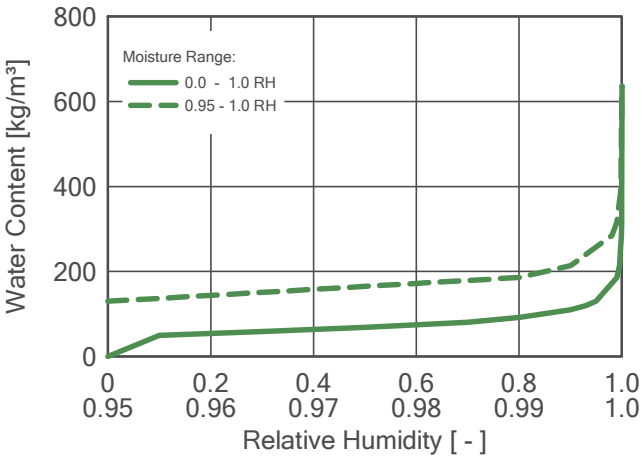
Material: *Smartply OSB3

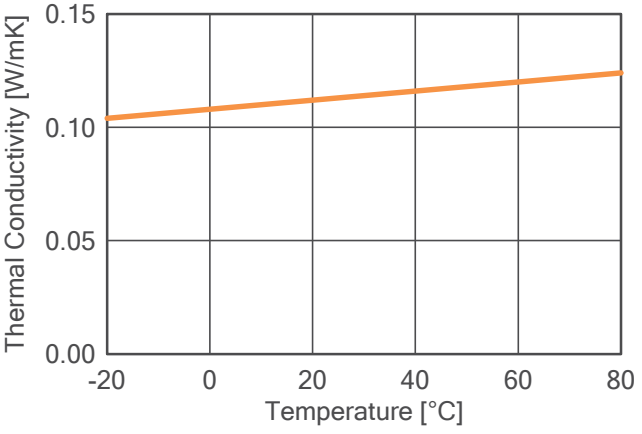
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





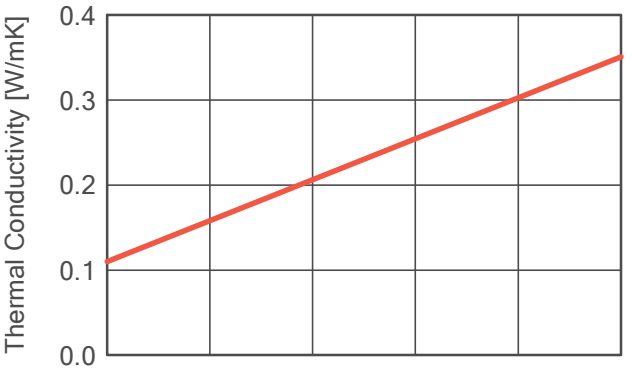


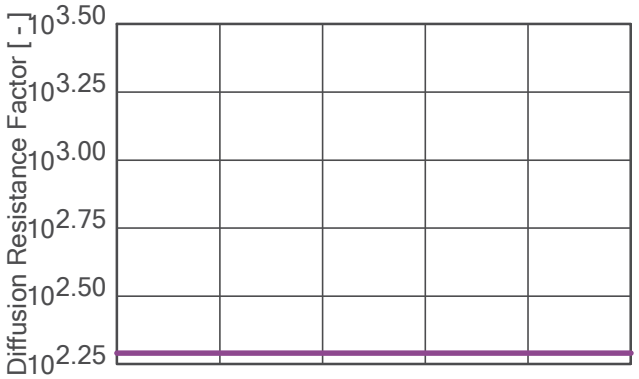


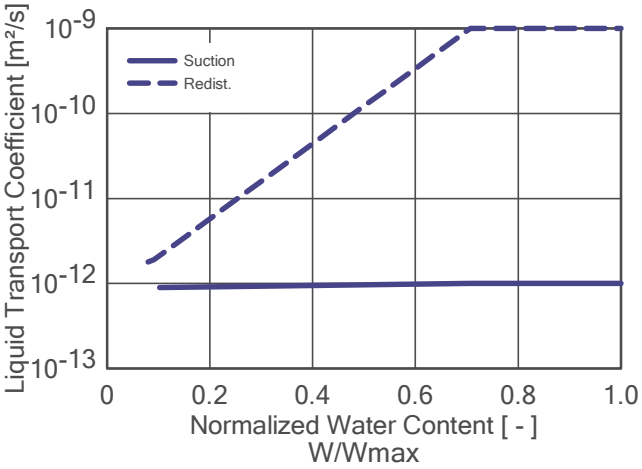


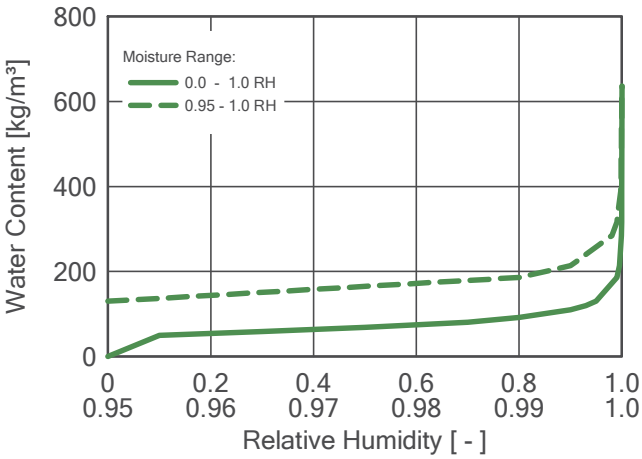
Material: *Smartply OSB3

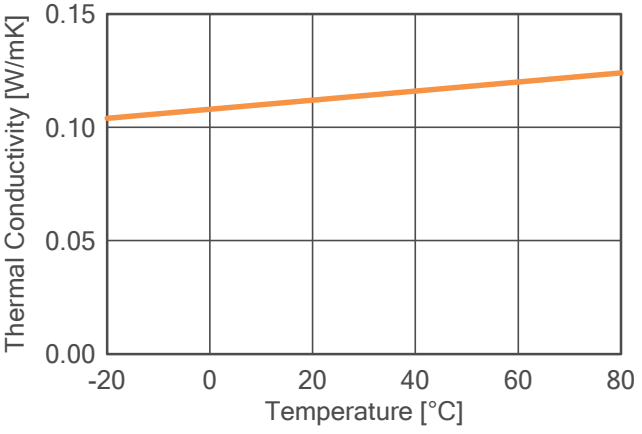
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





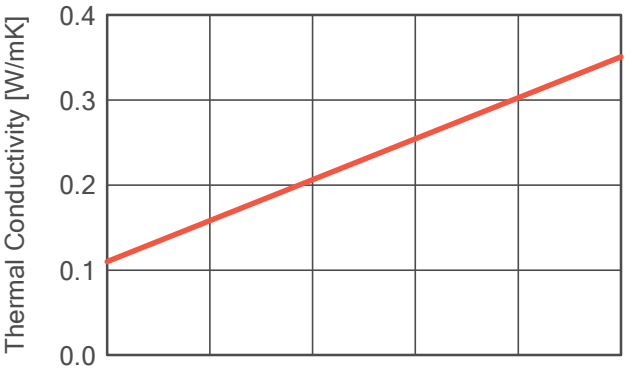


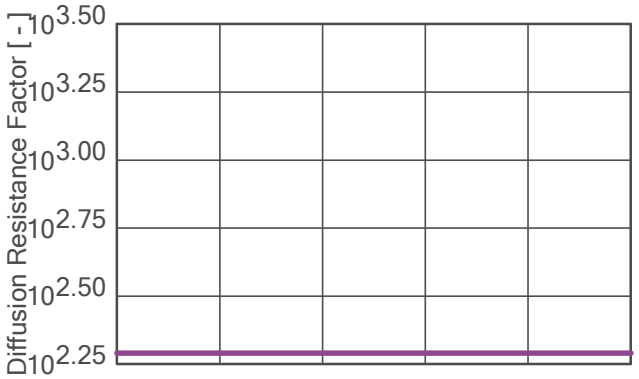


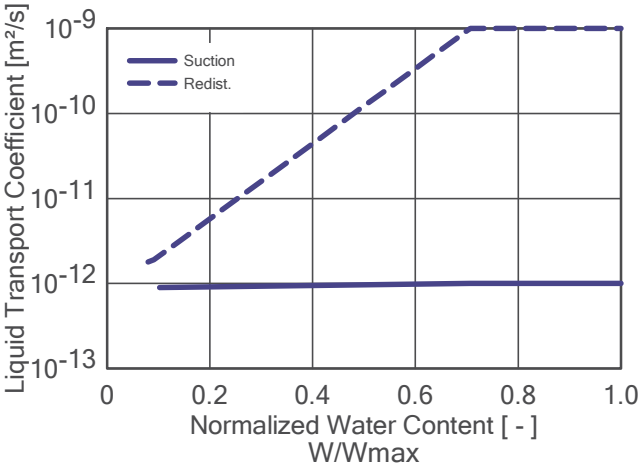


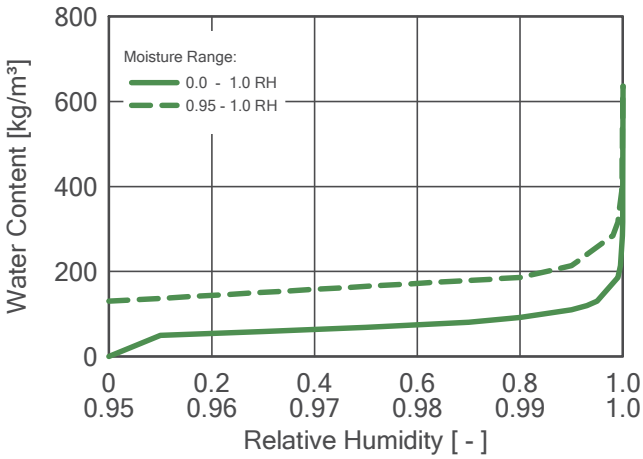
Material: *Smartply OSB3

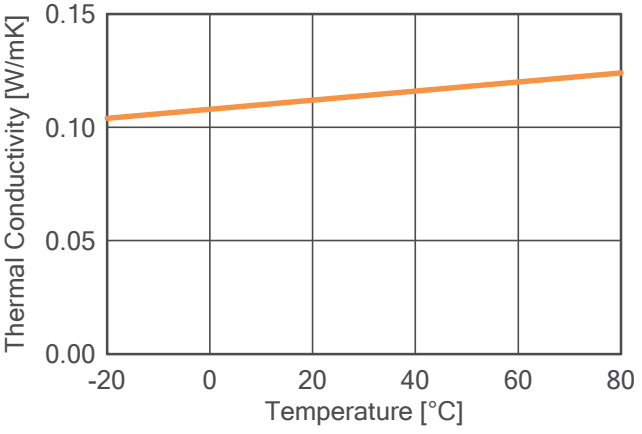
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





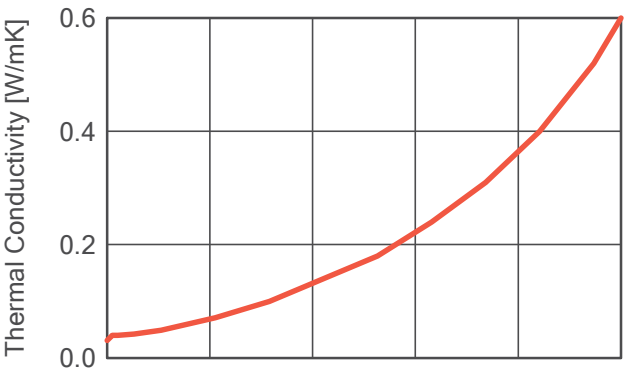


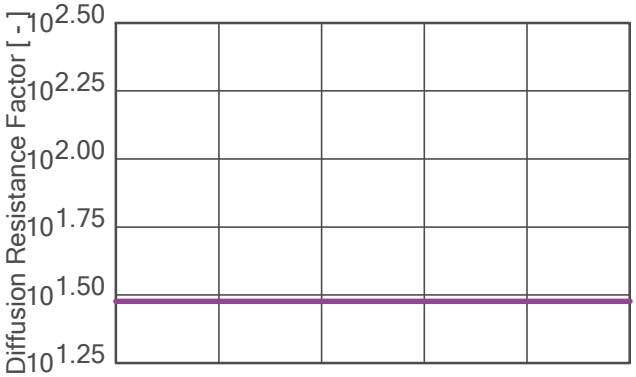


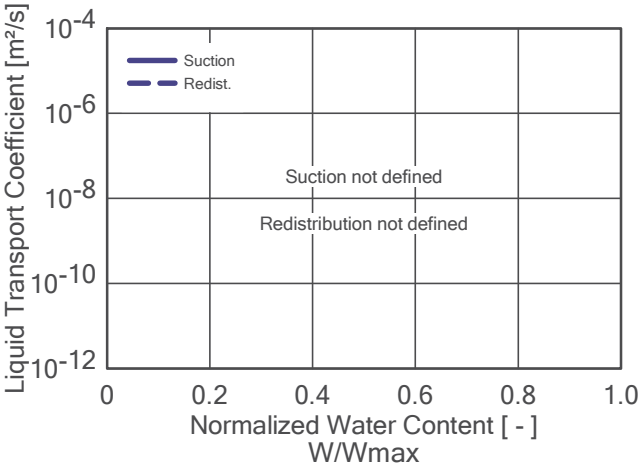


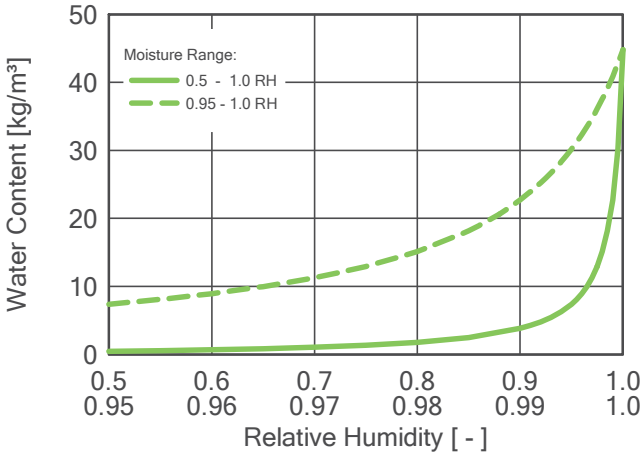
Material: *ACME EPS Silver 70

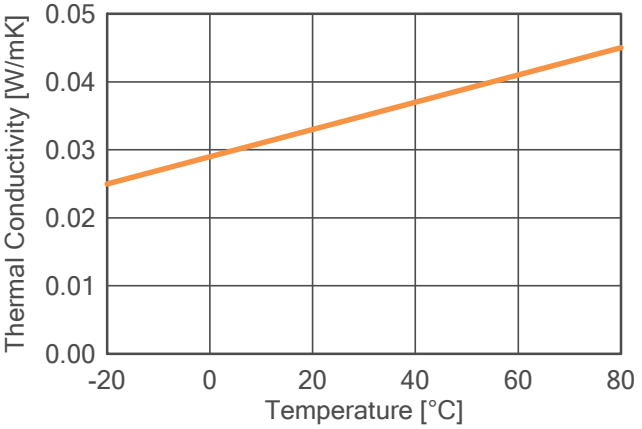
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





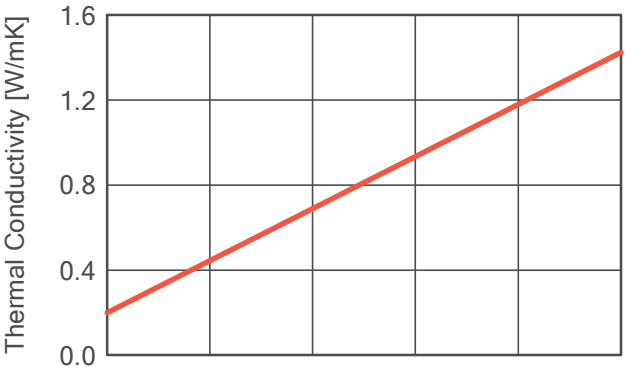


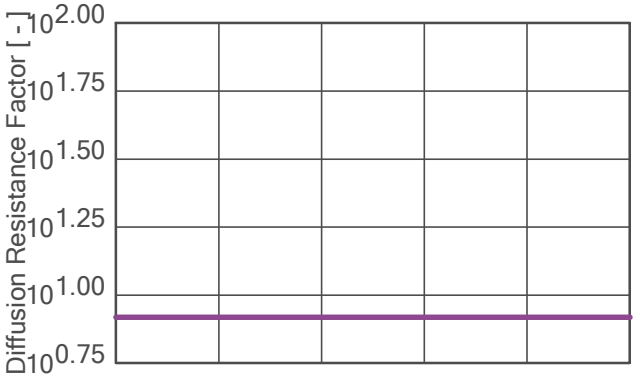


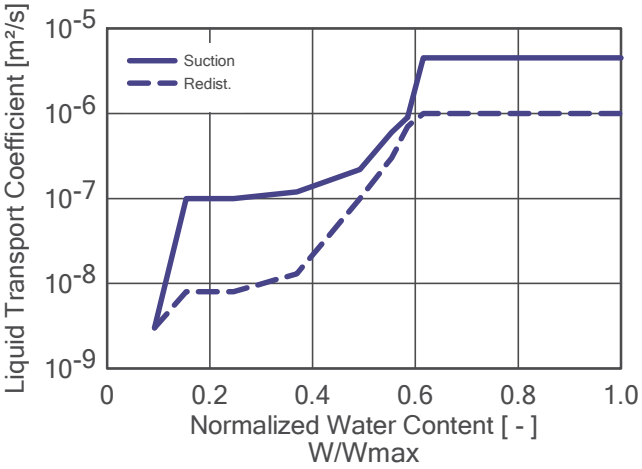


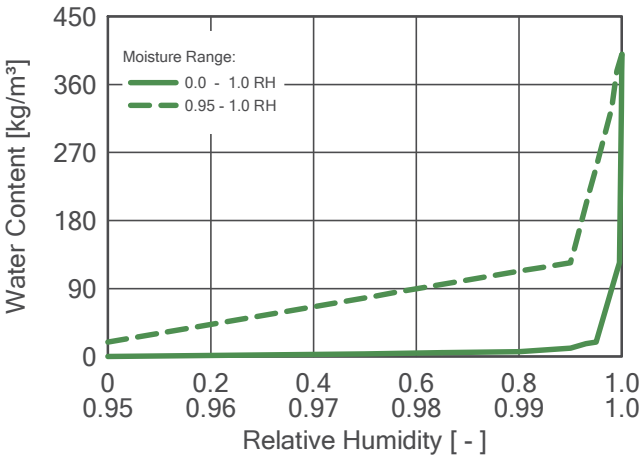
Material: Gypsum Board

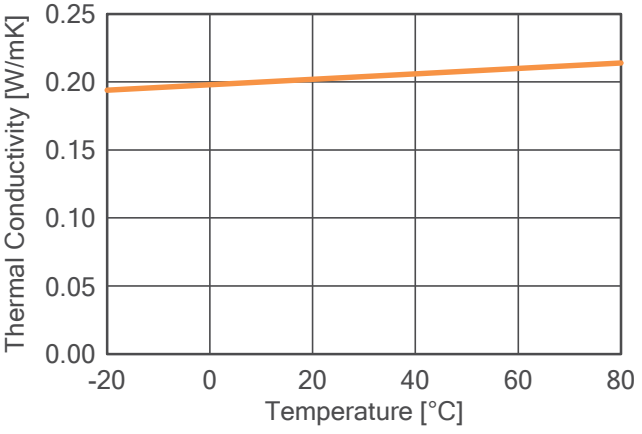
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	South / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 High Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 12:29:41
Computing Time	1 min,37 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -1.24
Integral of fluxes, right side (kr,dr)	[kg/m²]	3.3E-8 -0.46
Balance 1	[kg/m²]	-0.52
Balance 2	[kg/m²]	-0.63

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	2.12	1.6	1.55	2.12

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.16
*ACME White EPS 100	1.79	0.67	0.20	3.09
*Smartply OSB3	92.00	74.62	71.29	92.00
*Smartply OSB3	92.00	76.69	74.11	95.30
*Smartply OSB3	92.00	77.18	75.31	101.96
*ACME EPS Silver 70	1.79	0.83	0.80	1.79
Gypsum Board	6.30	4.97	3.58	6.30

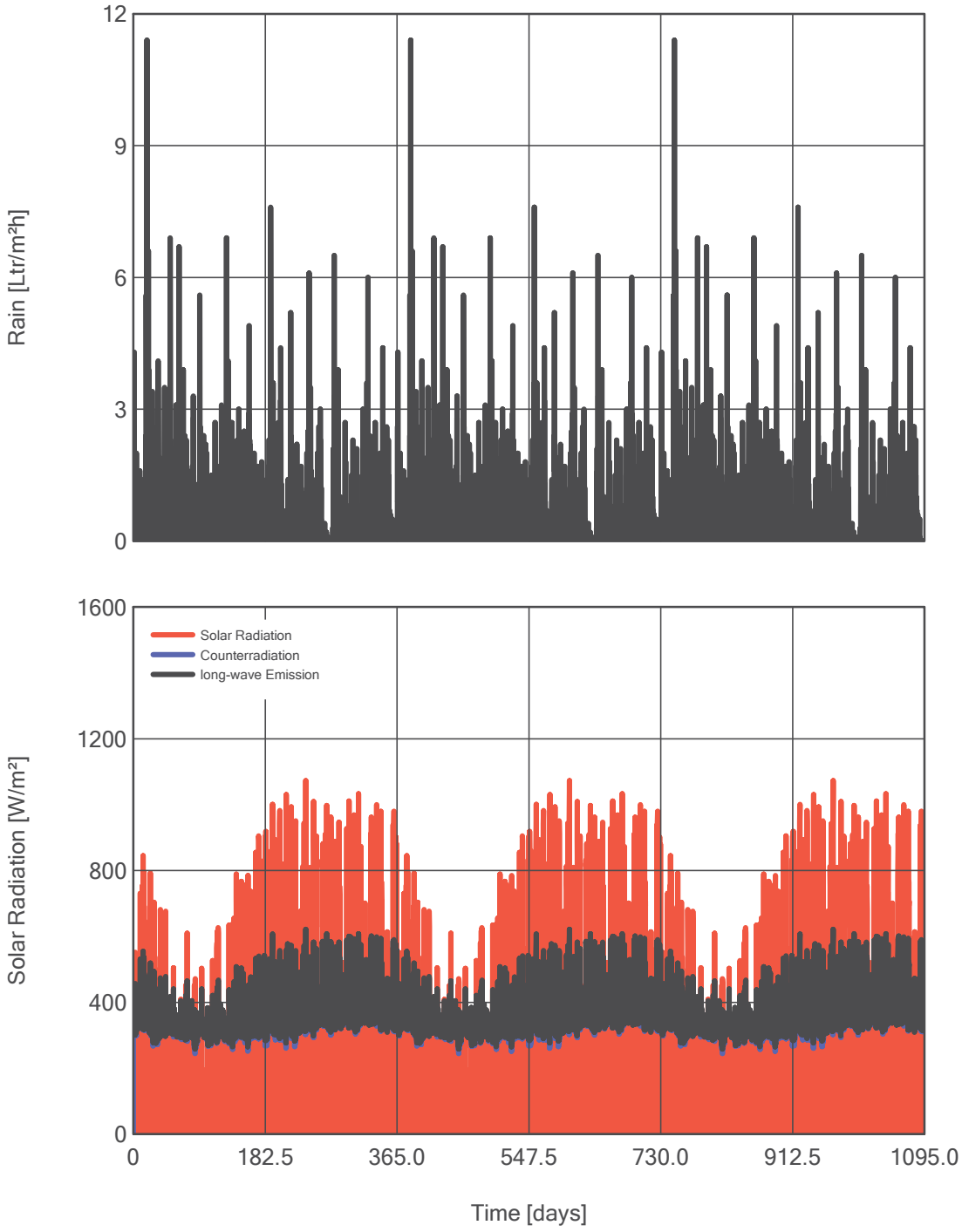
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-3878.98
Heat Flux, right side	[MJ/m²]	-96.66
Moisture Fluxes, left side	[kg/m²]	28.54
Moisture Fluxes, right side	[kg/m²]	-0.46

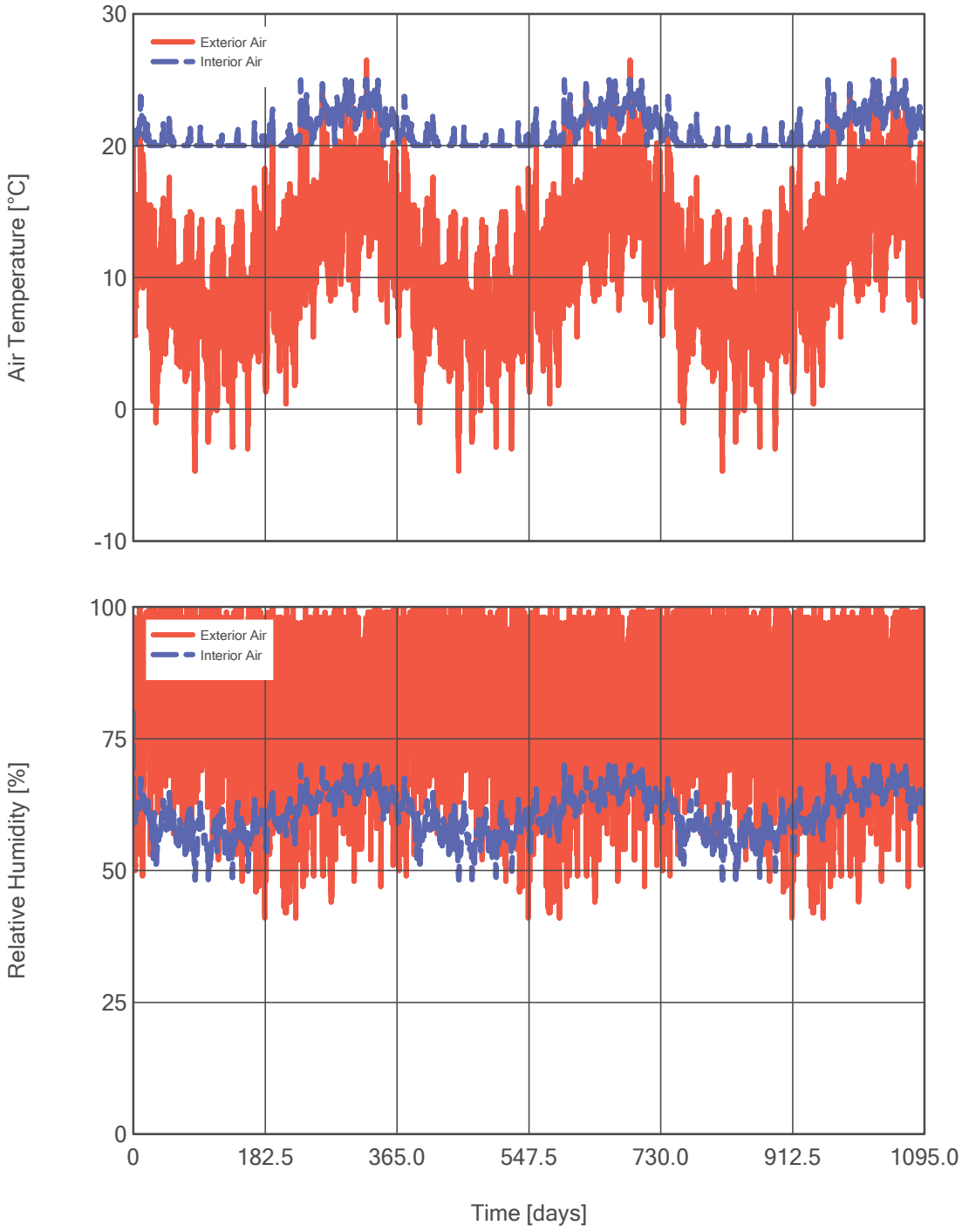
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.143
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.143

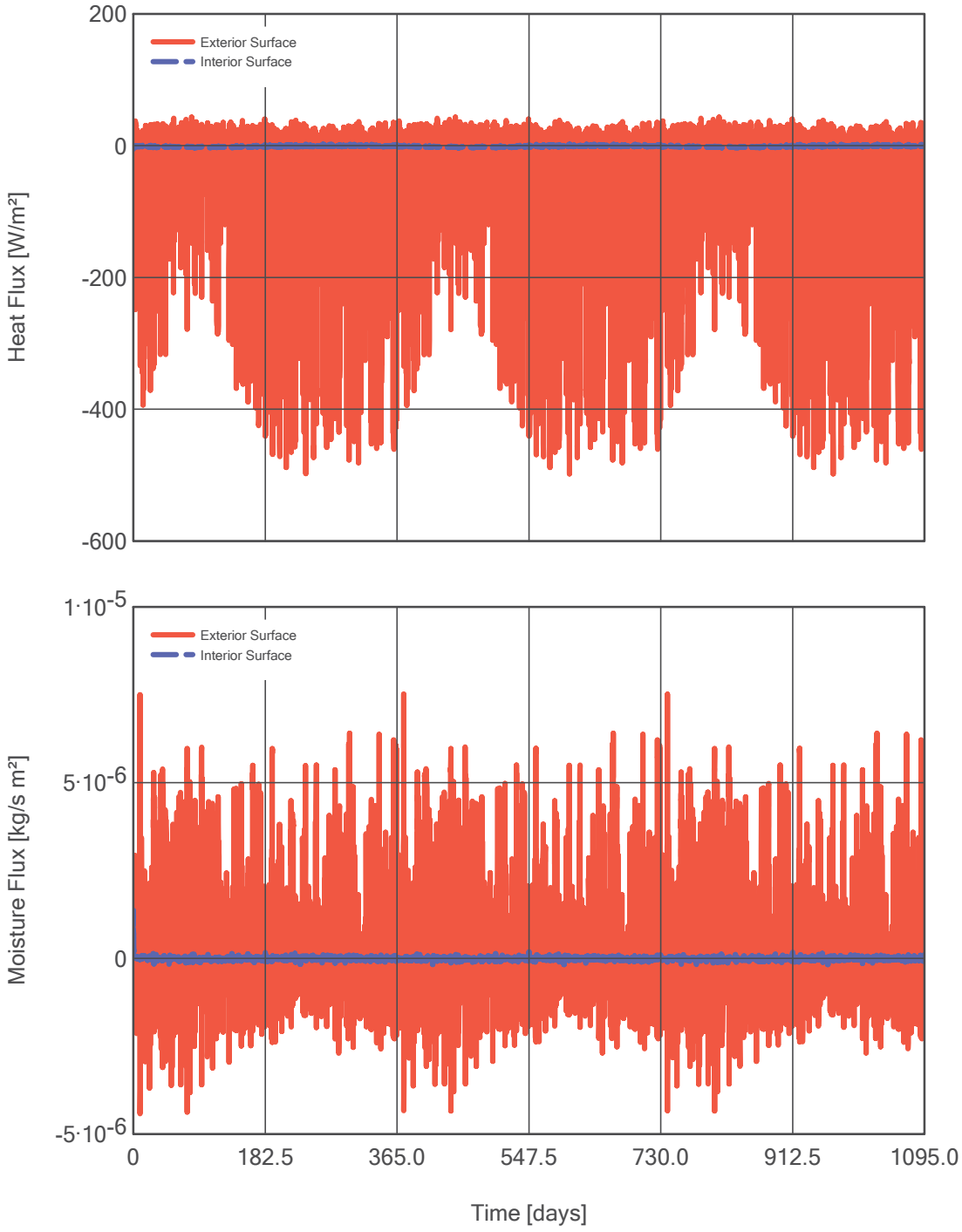
Rain, Radiation (Exterior Climate)



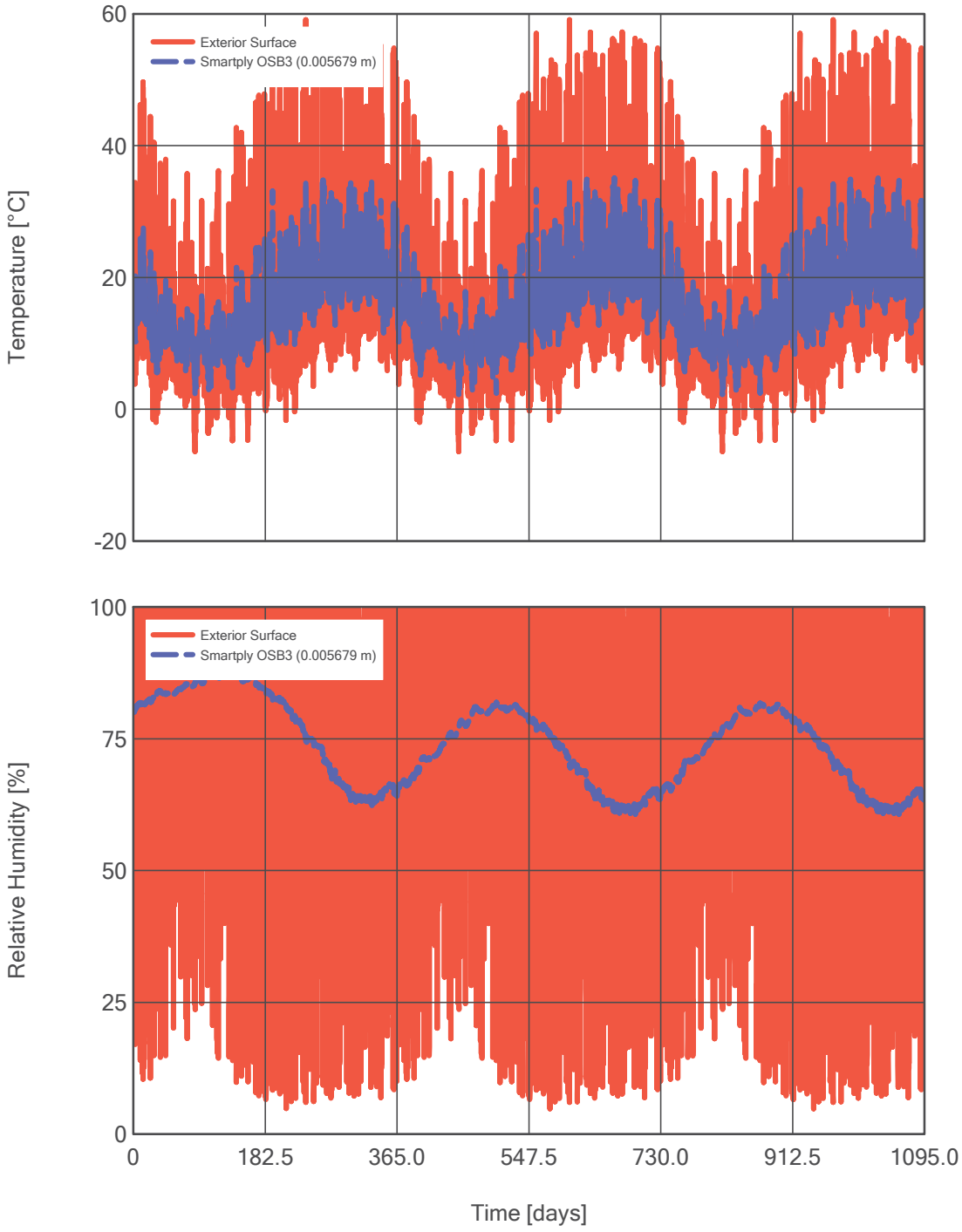
Air Temperature, RH (Exterior, Interior)



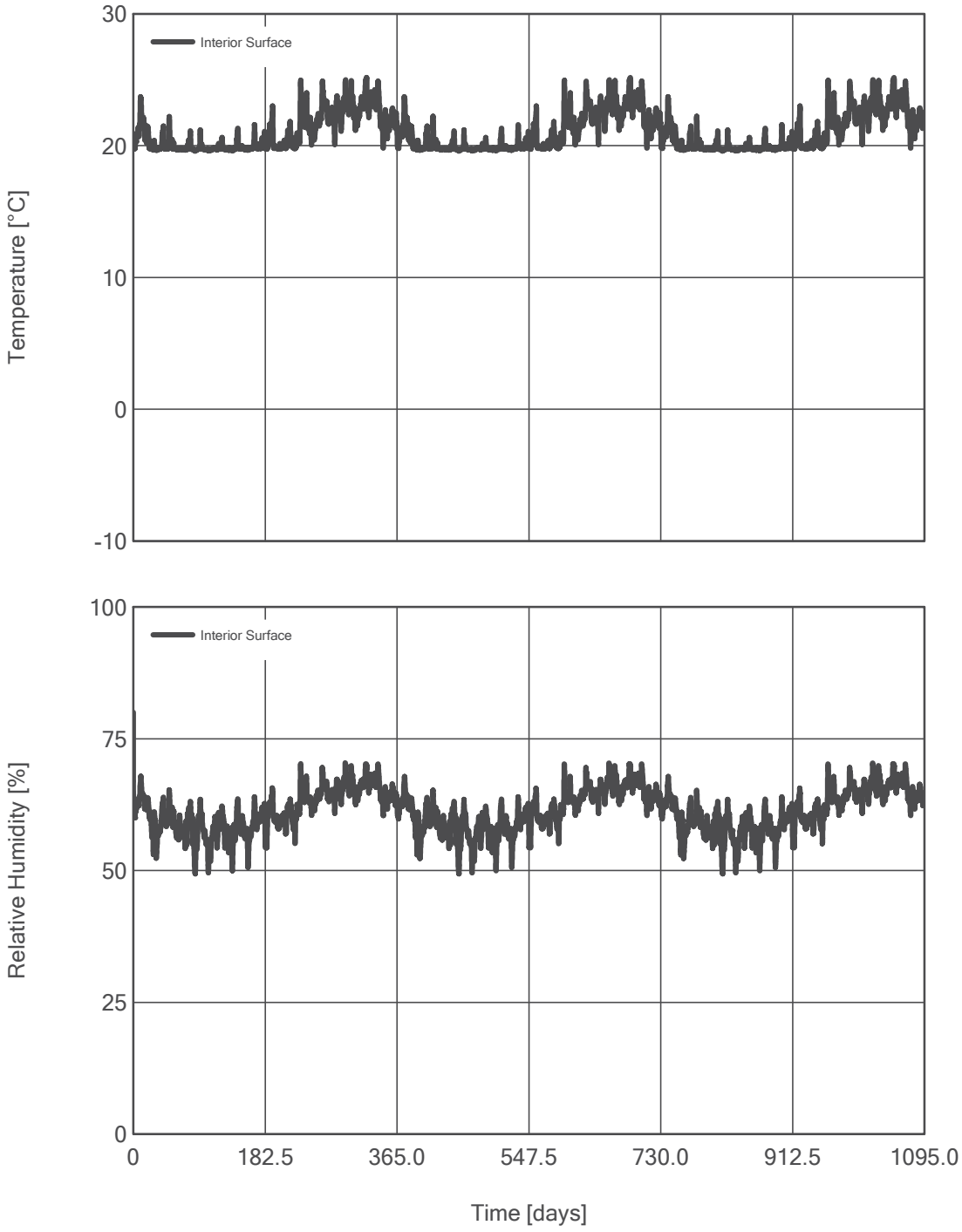
Heat, Moisture Fluxes



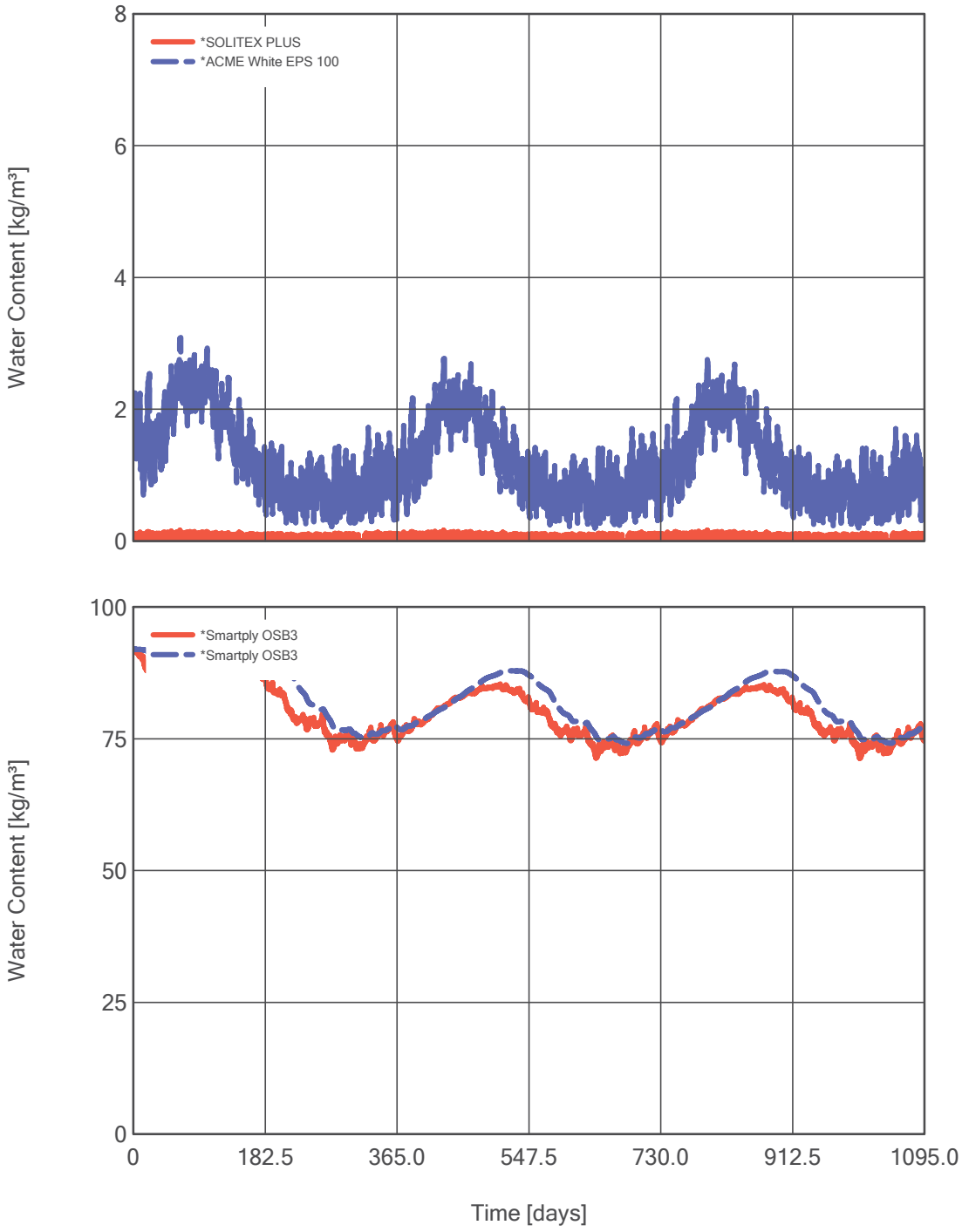
Temperature, RH (Monitor Position 1, 2)



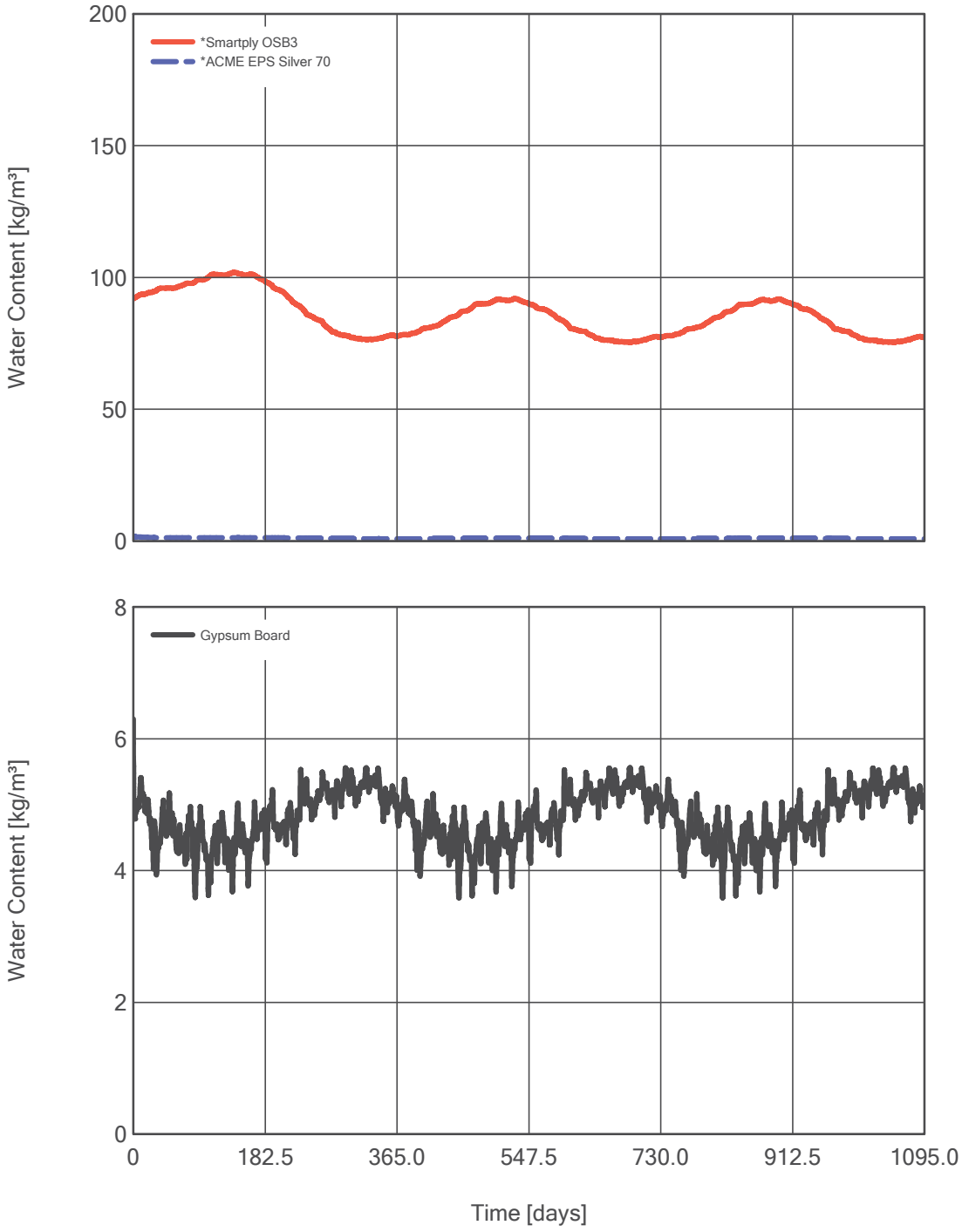
Temperature, RH (Monitor Position 3)



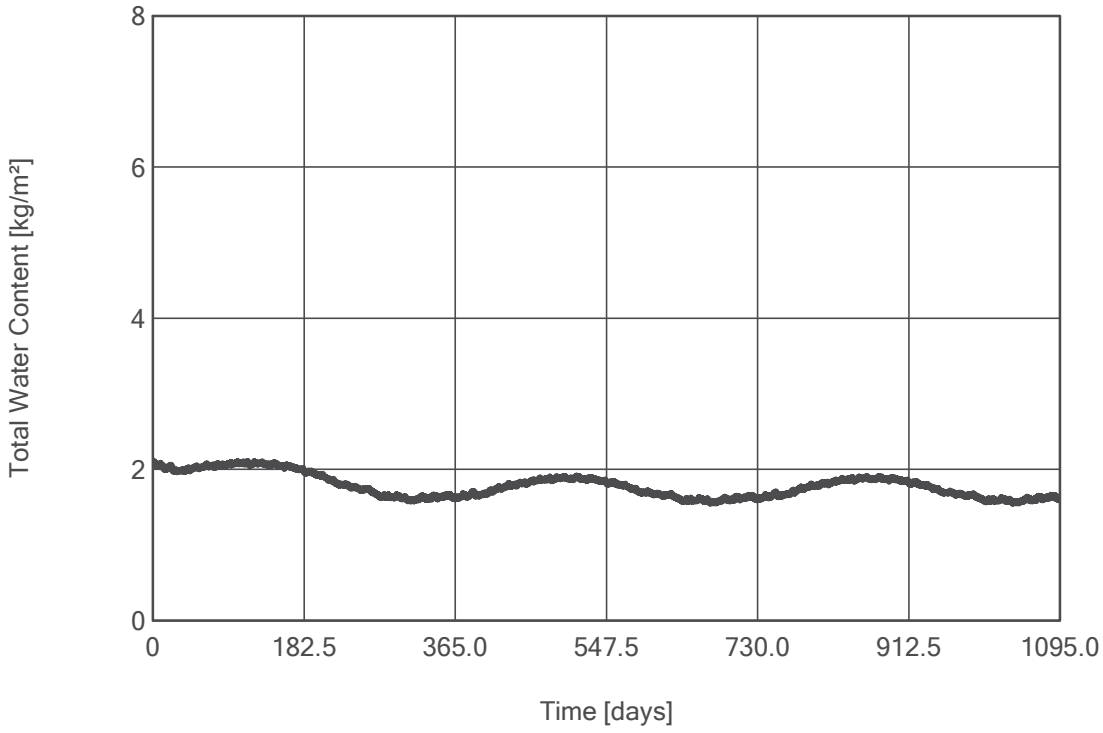
Water Content of Individual Materials



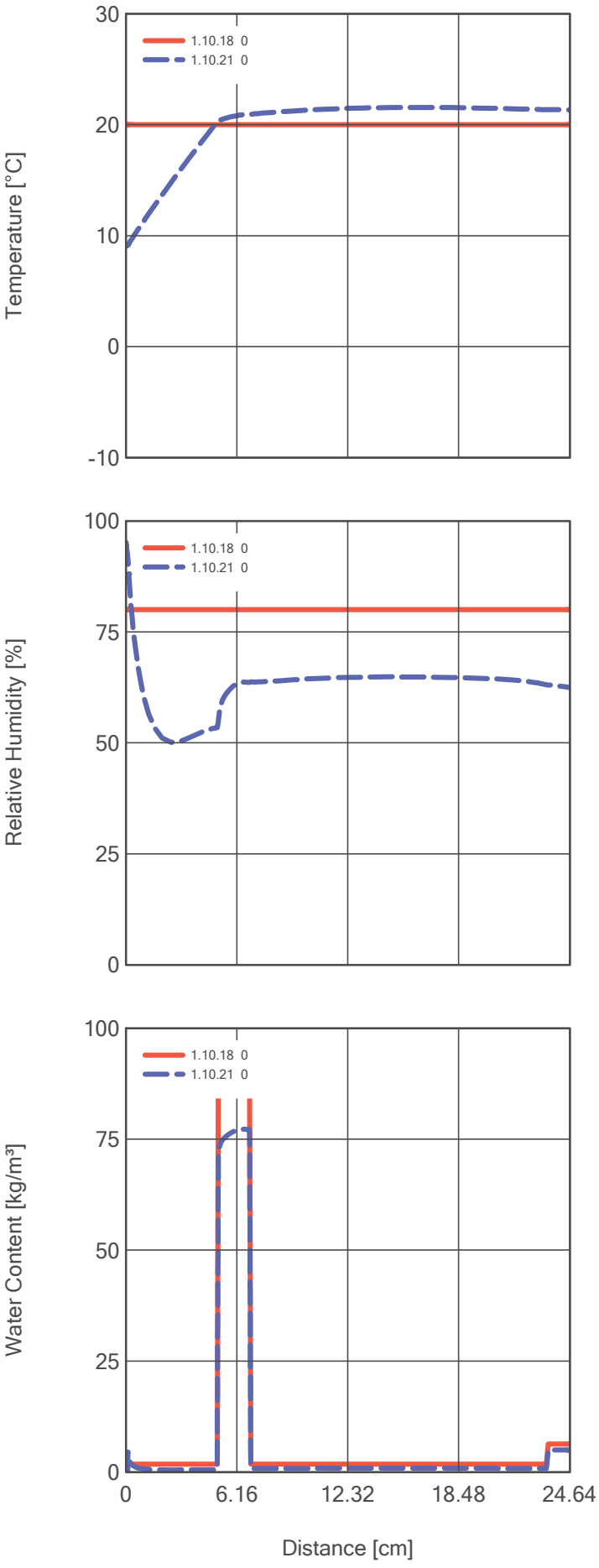
Water Content of Individual Materials



Total Water Content in Construction



Profiles

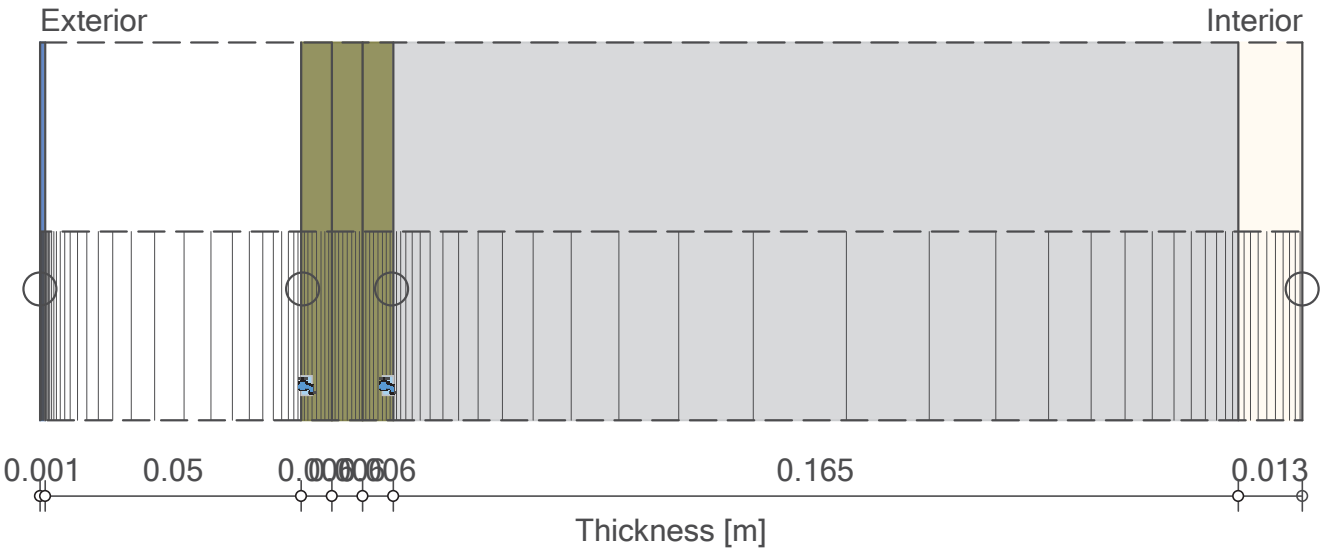

30
20
10
0
-10
Temperature [°C]
1.10.18 0
1.10.21 0
100
75
50
25
0
Relative Humidity [%]
1.10.18 0
1.10.21 0
100
75
50
25
0
Water Content [kg/m³]
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #5 South Pitched Roof, leaking SOLITEX, Medium moisture load & 10A



- Monitor positions

- Heat/Moisture source/sink positions

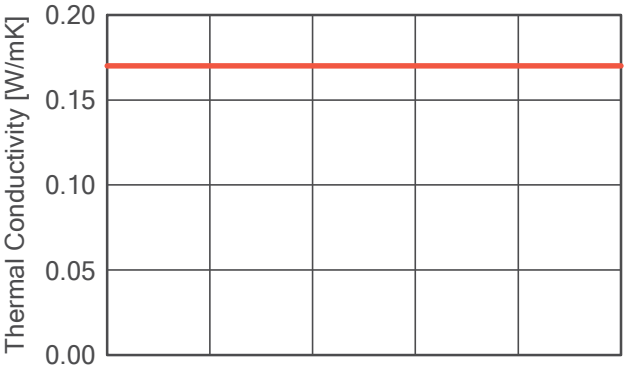
Materials:

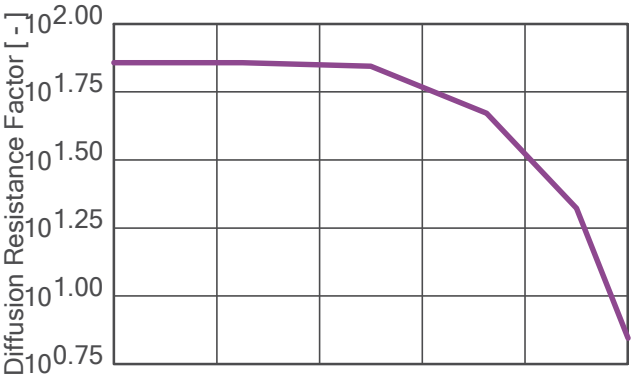
	- *SOLITEX PLUS	0.001 m
	- *ACME White EPS 100	0.05 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *ACME EPS Silver 70	0.165 m
	- Gypsum Board	0.013 m

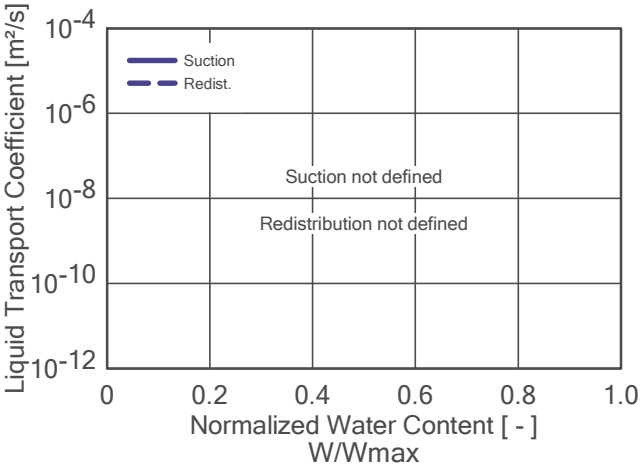
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

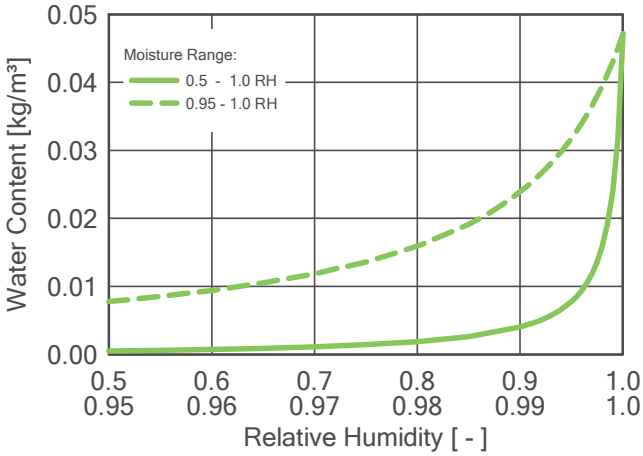
Material: *SOLITEX PLUS

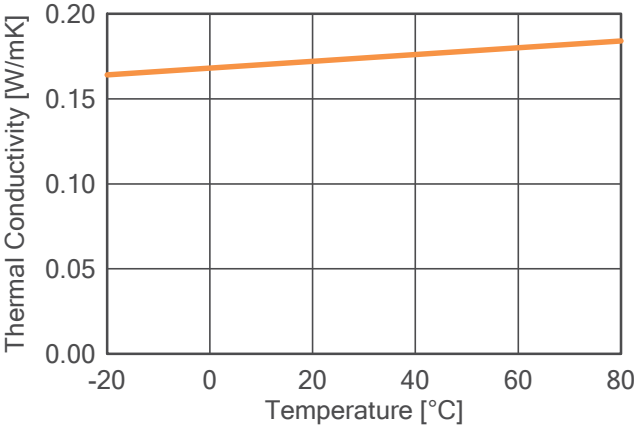
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





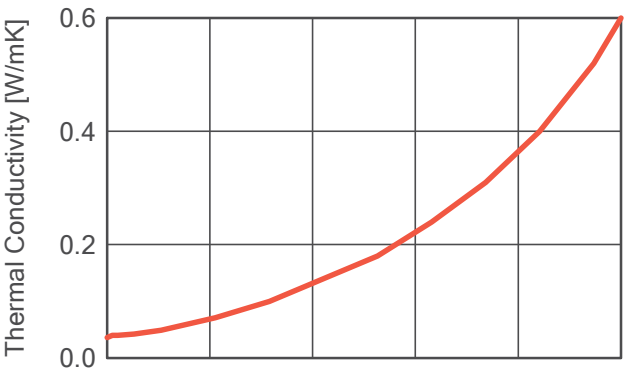


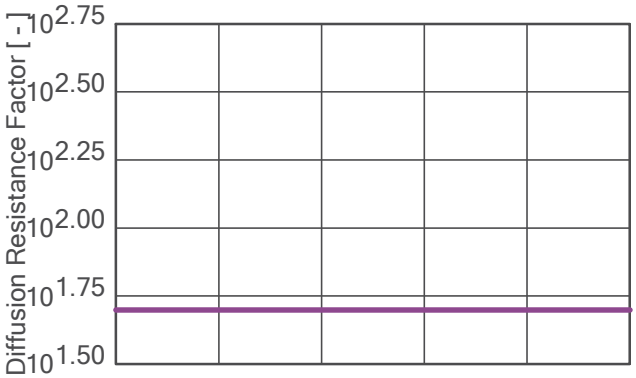


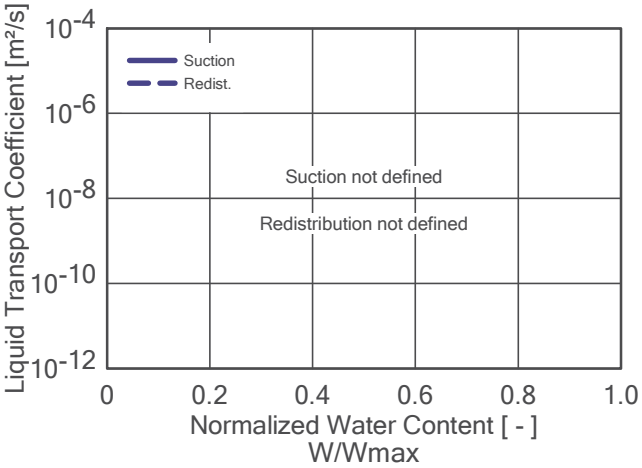


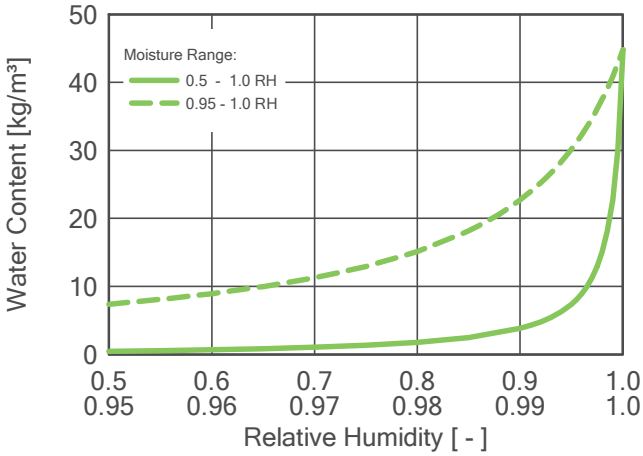
Material: *ACME White EPS 100

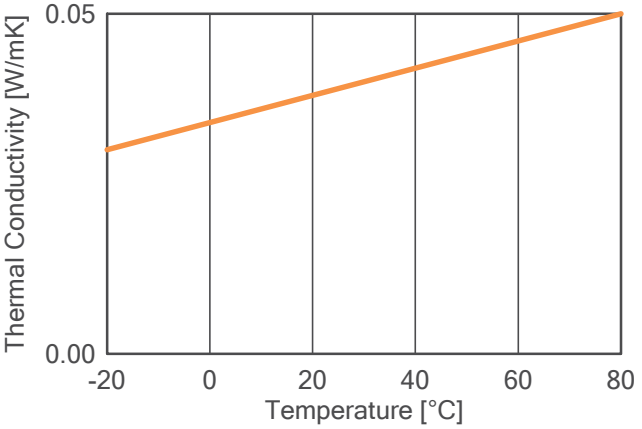
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





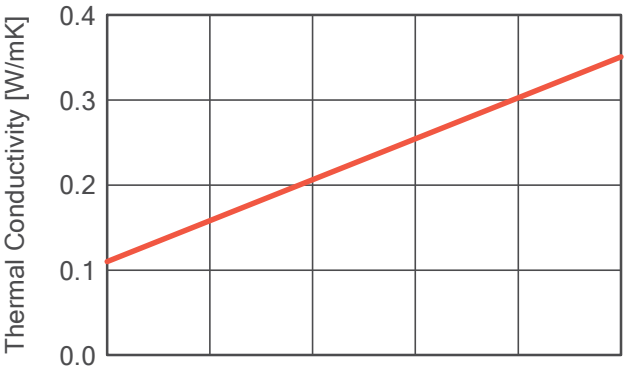


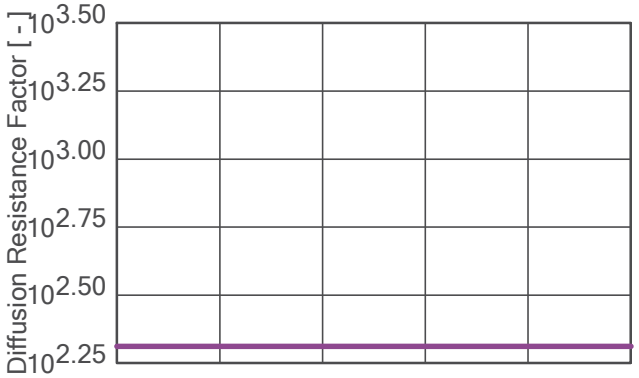


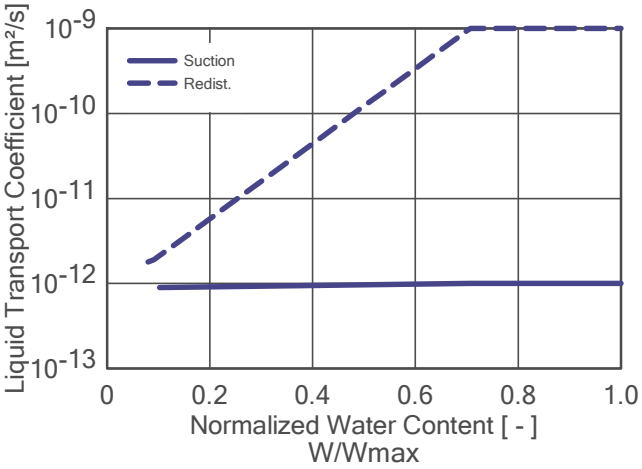


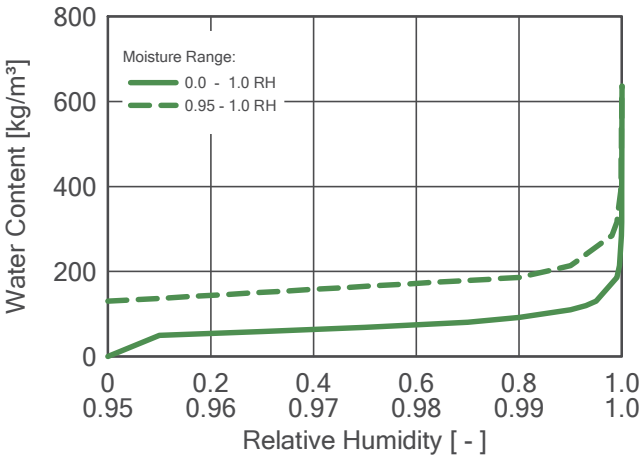
Material: *Smartply OSB3

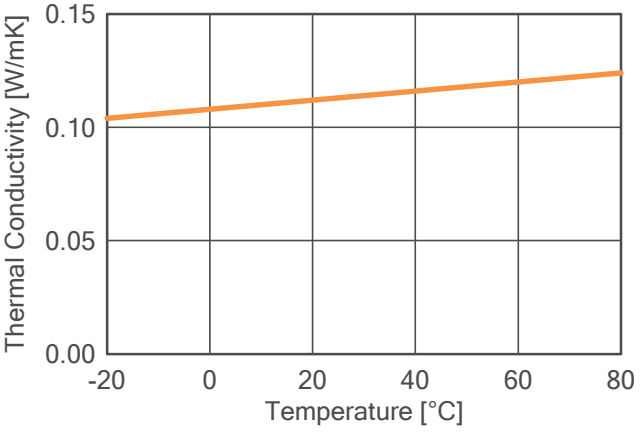
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	205.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





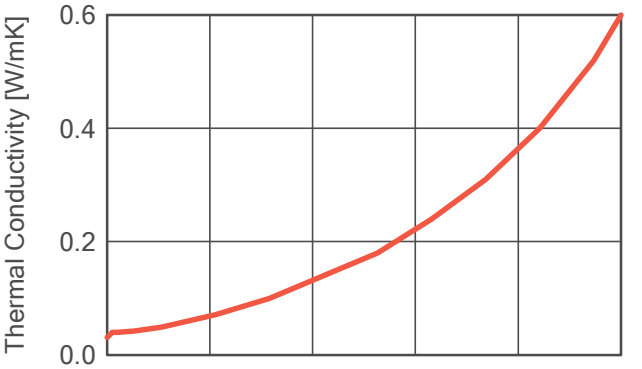


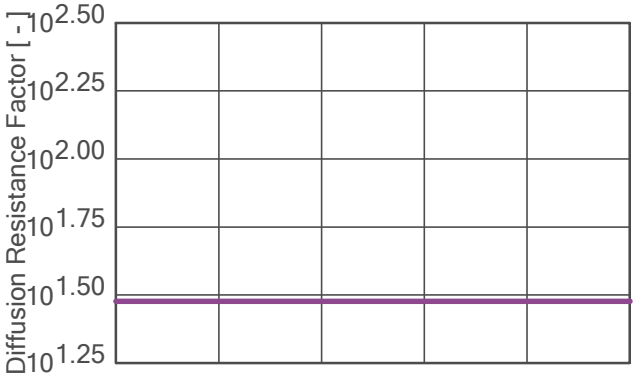


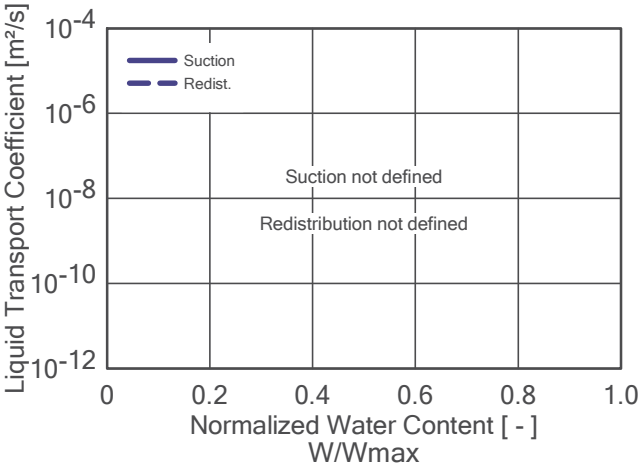


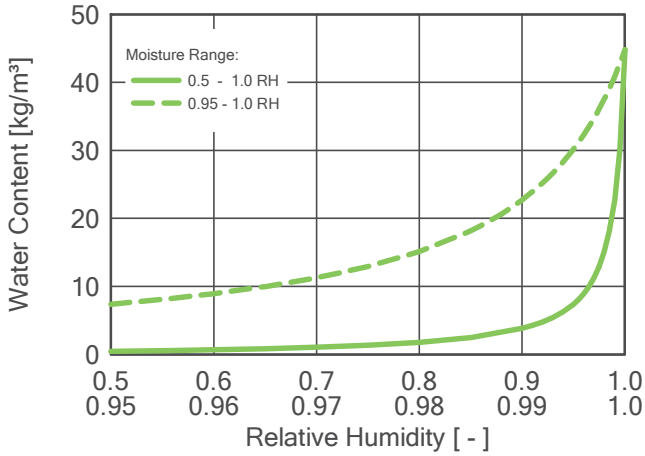
Material: *ACME EPS Silver 70

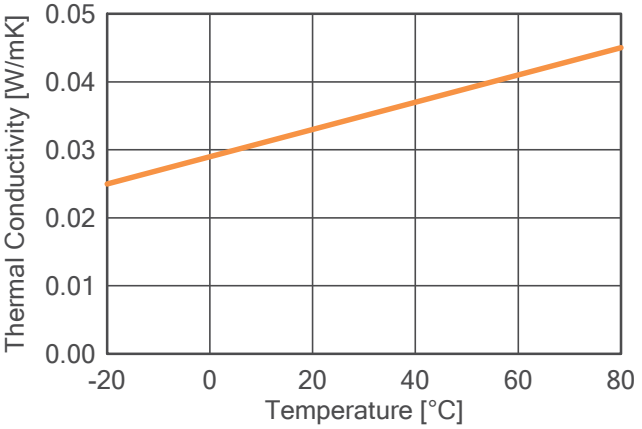
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





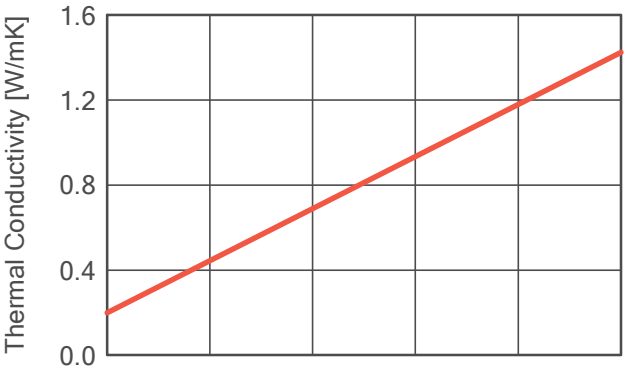


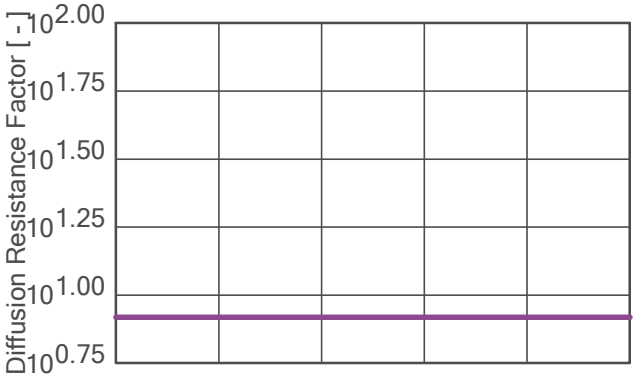


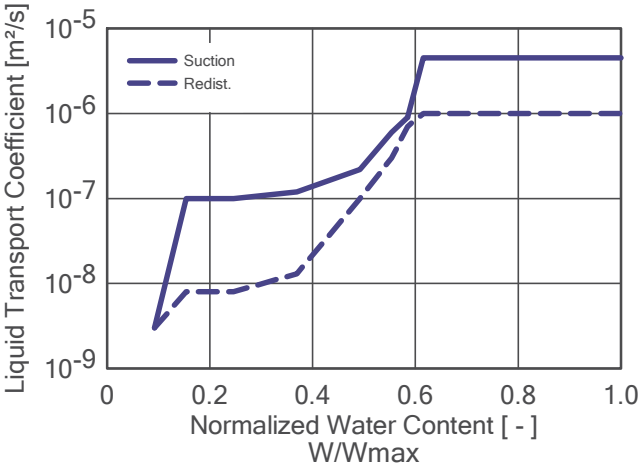


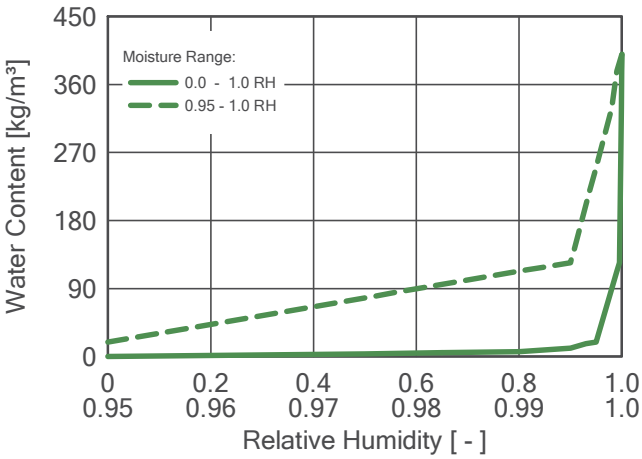
Material: Gypsum Board

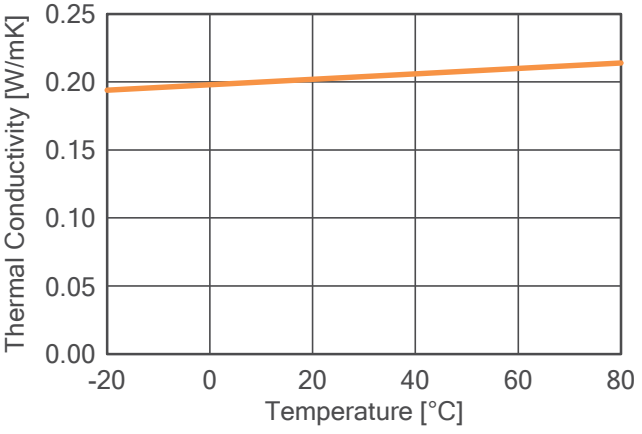
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	South / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 Medium Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Source1	*Moisture Source*		
	Start Depth in Layer	[m]	0.00
	End Depth in Layer	[m]	0.002
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Fraction of Driving Rain	[%]	1

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	01/06/2018 10:06:44
Computing Time	1 min,5 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -5.4
Integral of fluxes, right side (kr,dr)	[kg/m²]	1.5E-7 2.1
Balance 1	[kg/m²]	10.08
Balance 2	[kg/m²]	9.94

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	2.12	12.2	2.08	12.43

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.20
*ACME White EPS 100	1.79	3.90	1.76	8.94
*Smartply OSB3	92.00	631.31	91.97	636.00
*Smartply OSB3	92.00	631.62	91.99	635.93
*Smartply OSB3	92.00	631.49	92.00	635.98
*ACME EPS Silver 70	1.79	3.55	1.01	3.61
Gypsum Board	6.30	3.96	2.85	6.30

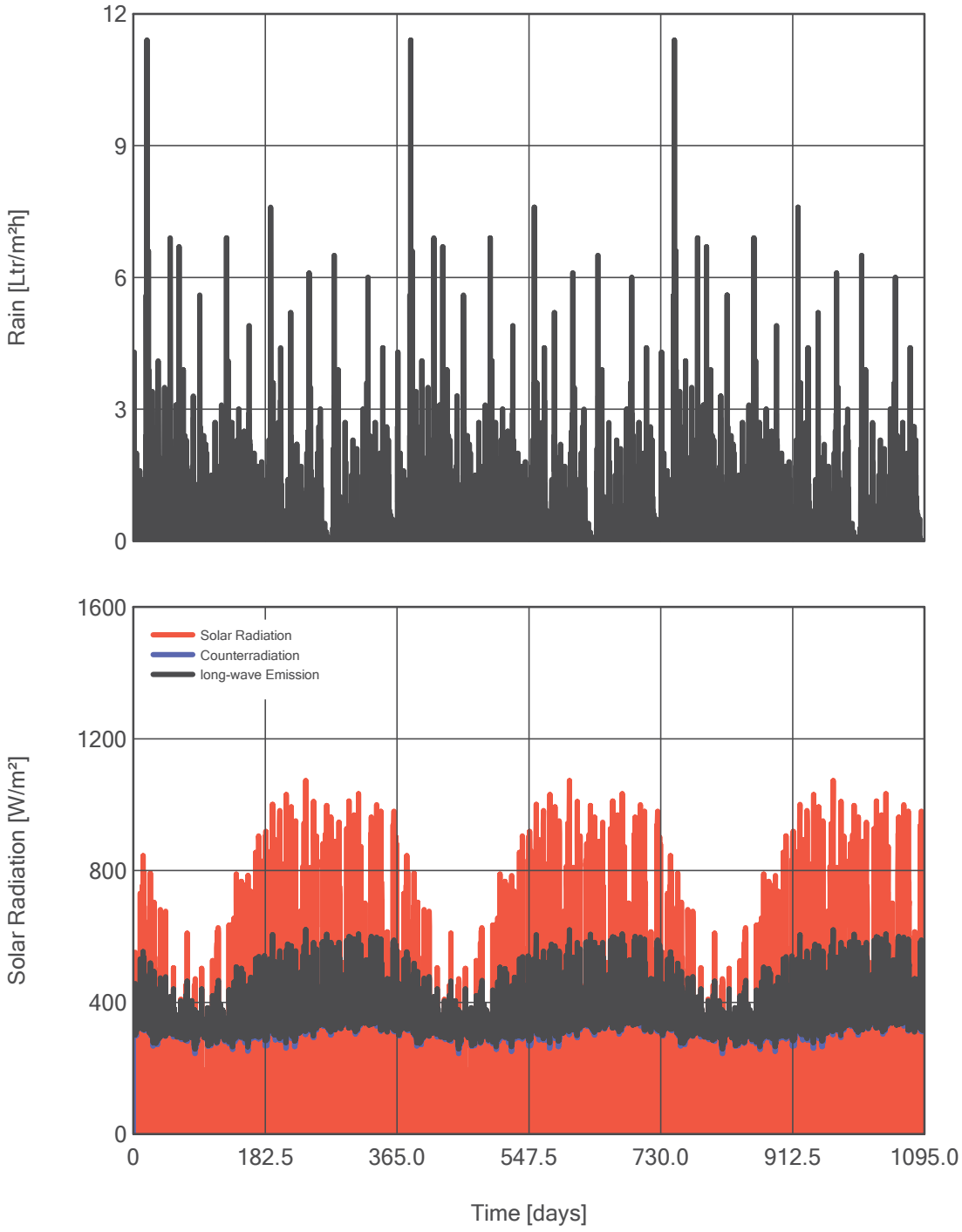
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-3872.2
Heat Flux, right side	[MJ/m²]	-103.76
Moisture Fluxes, left side	[kg/m²]	23.58
Moisture Fluxes, right side	[kg/m²]	2.1

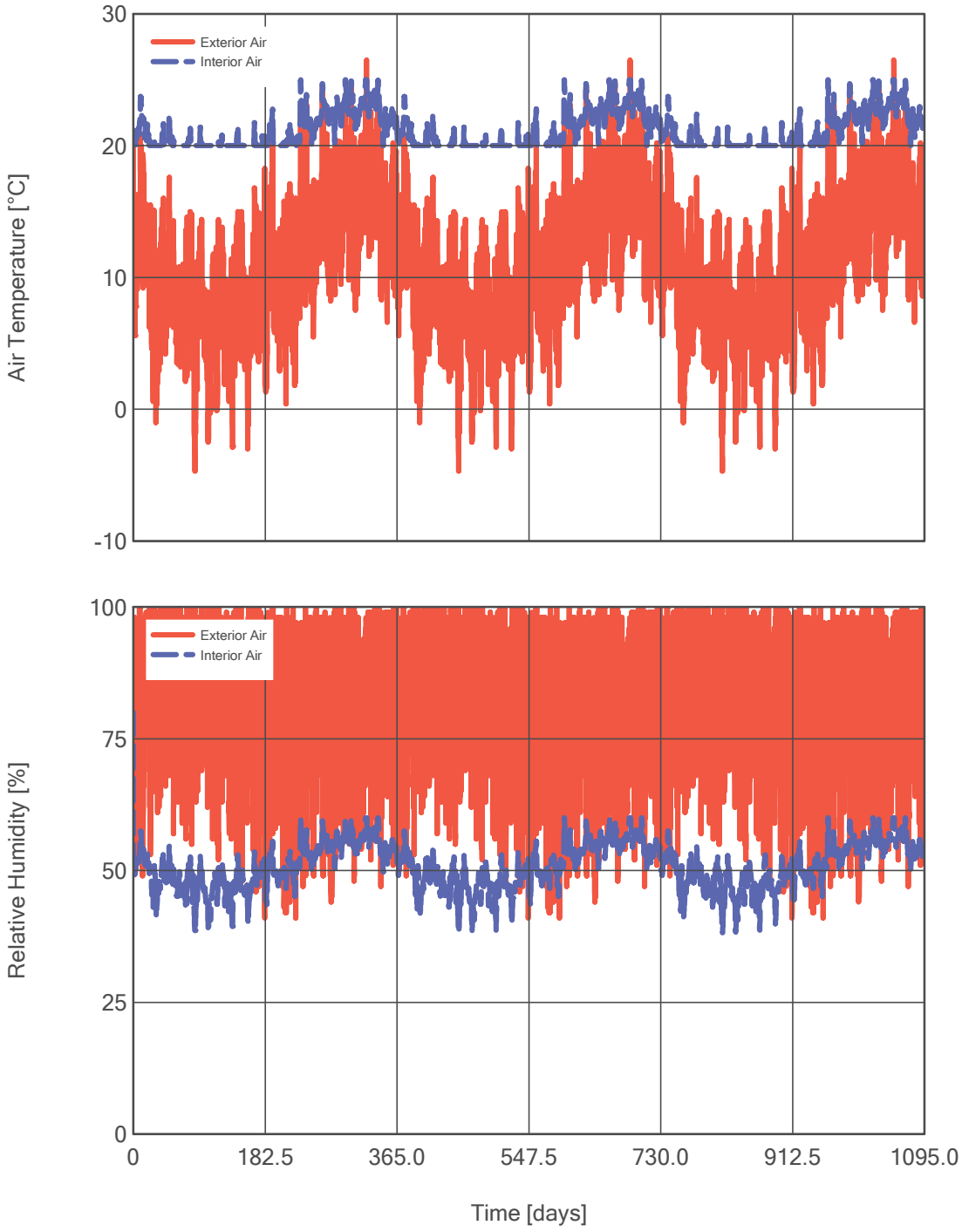
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	24.078
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	1.631
Source1 (Moisture Source)	[kg/m²]	24.071
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.007

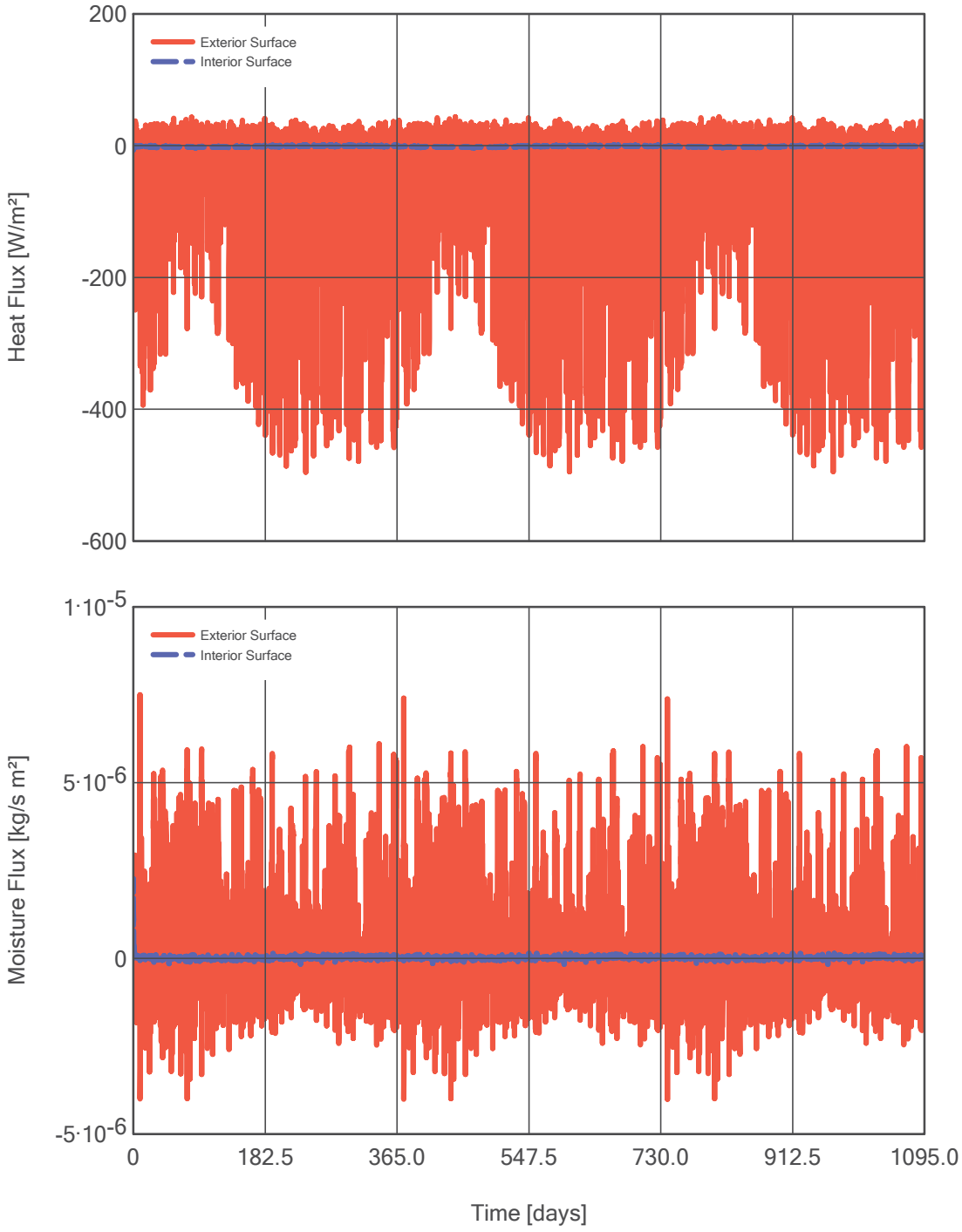
Rain, Radiation (Exterior Climate)



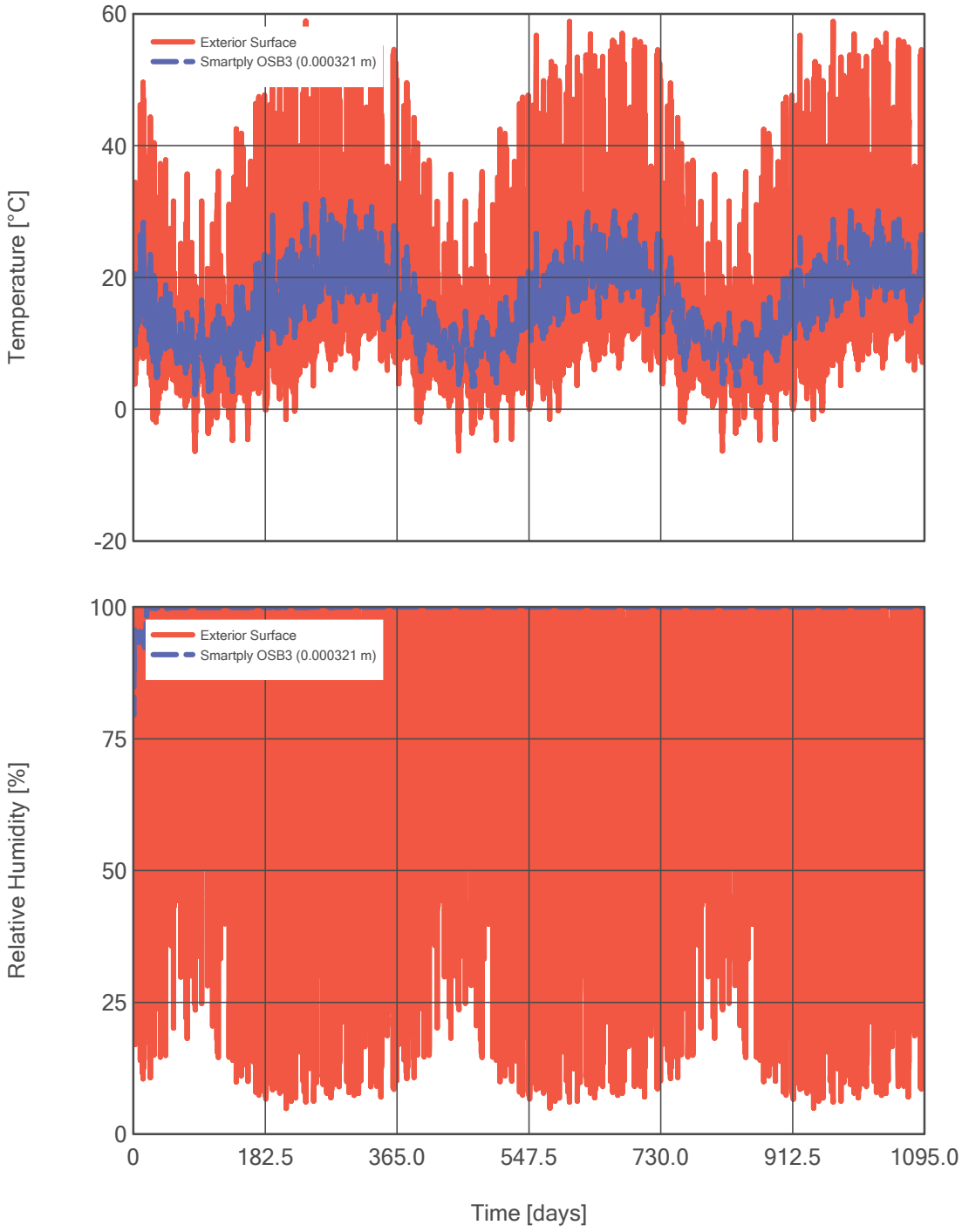
Air Temperature, RH (Exterior, Interior)



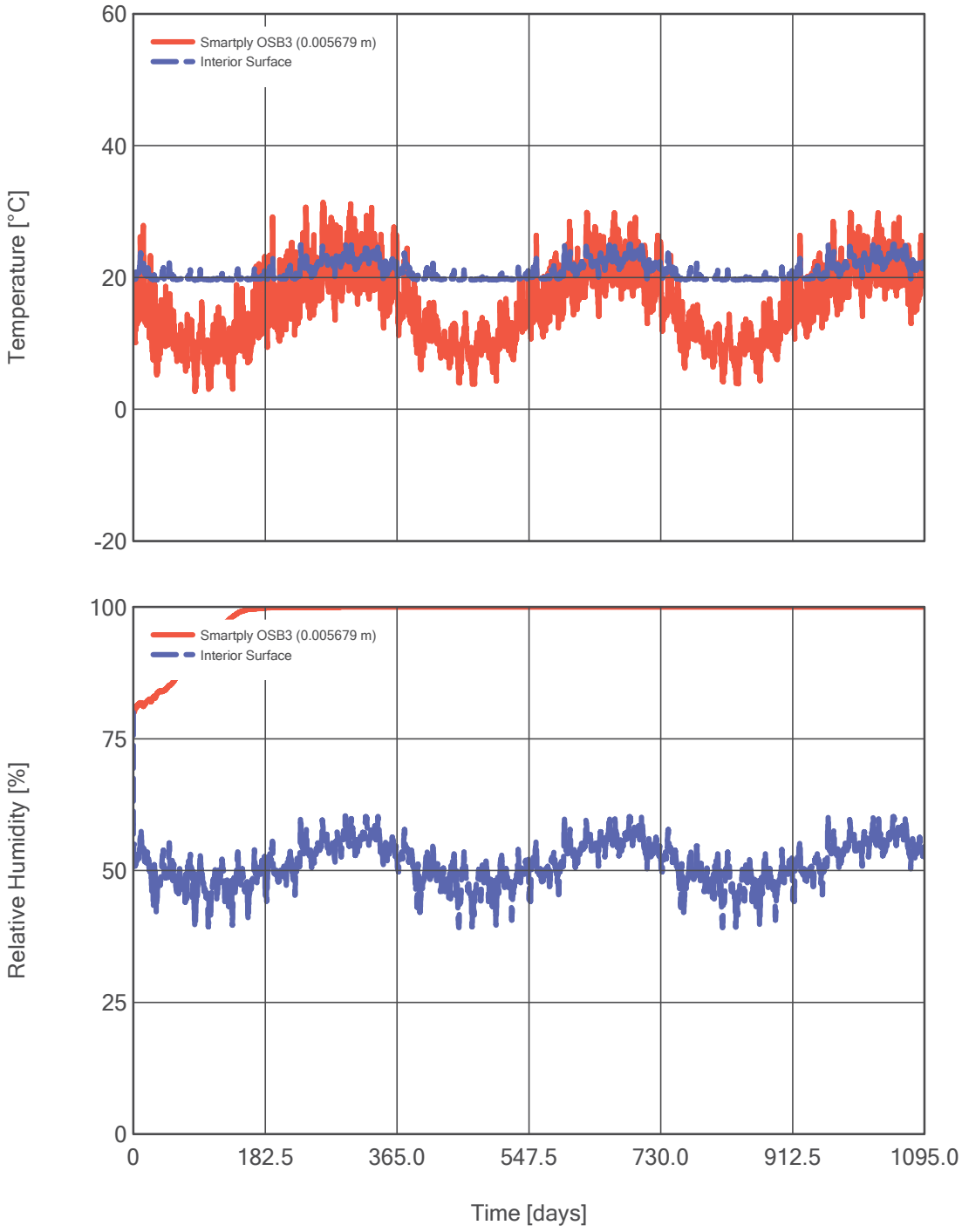
Heat, Moisture Fluxes



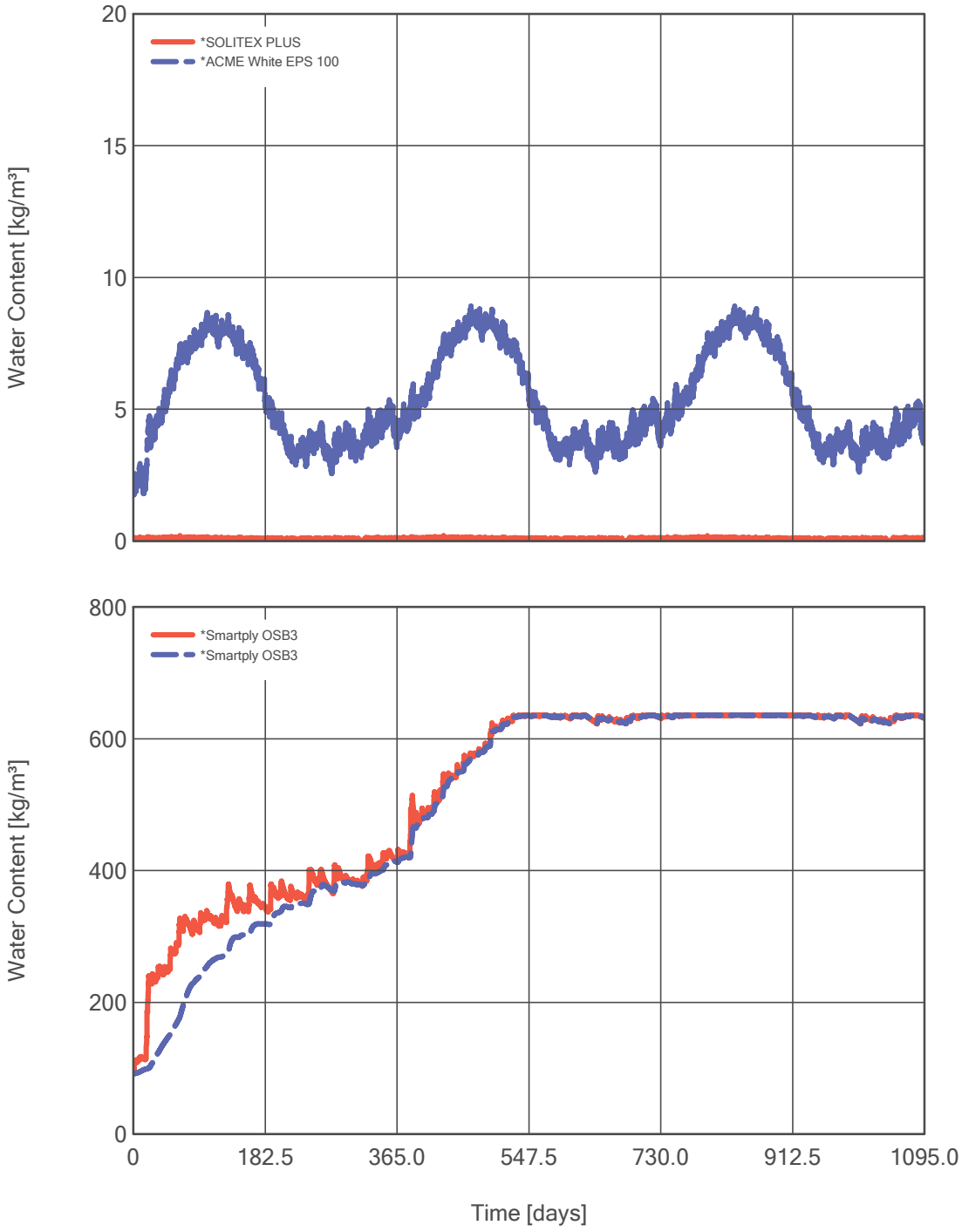
Temperature, RH (Monitor Position 1, 2)



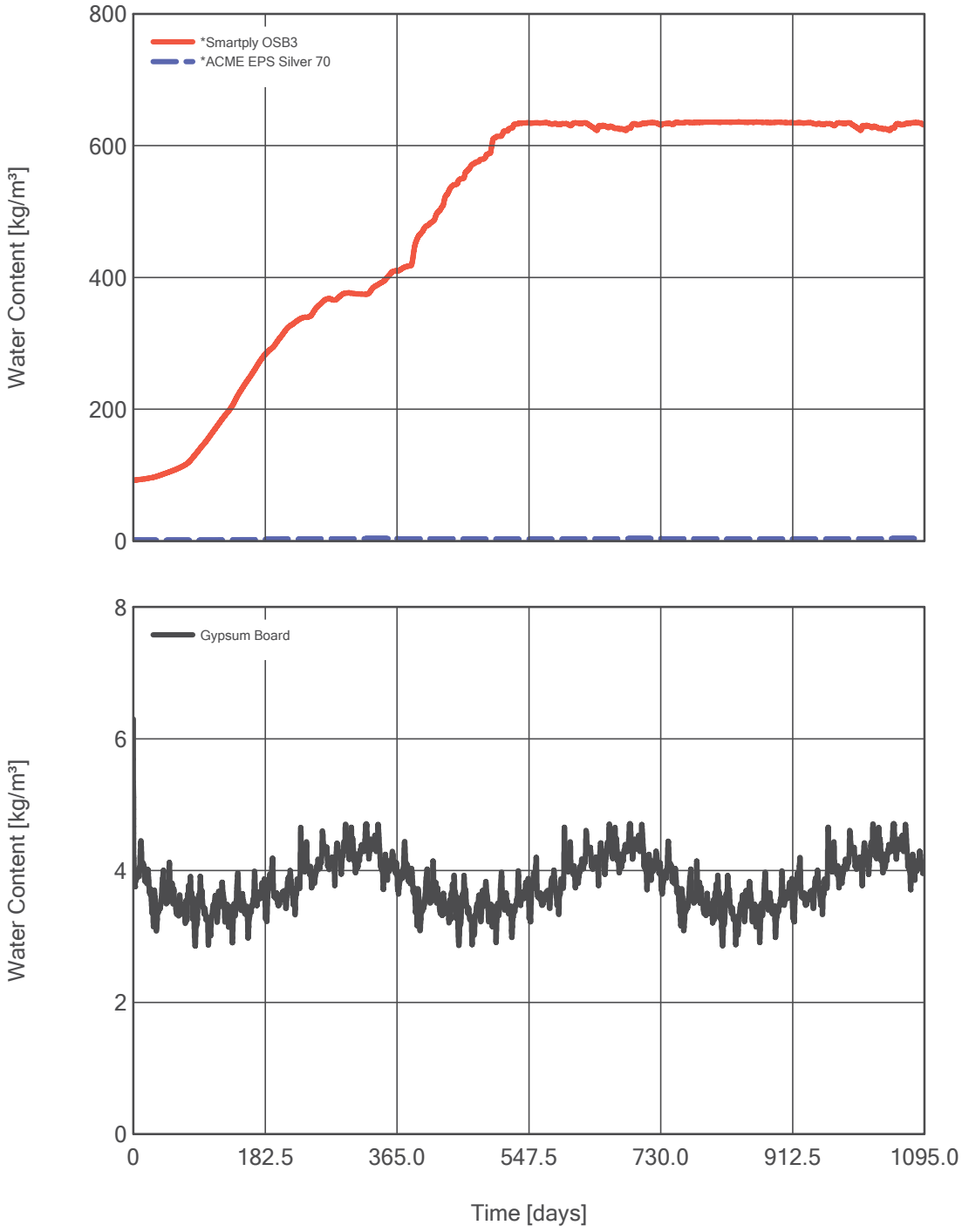
Temperature, RH (Monitor Position 3, 4)



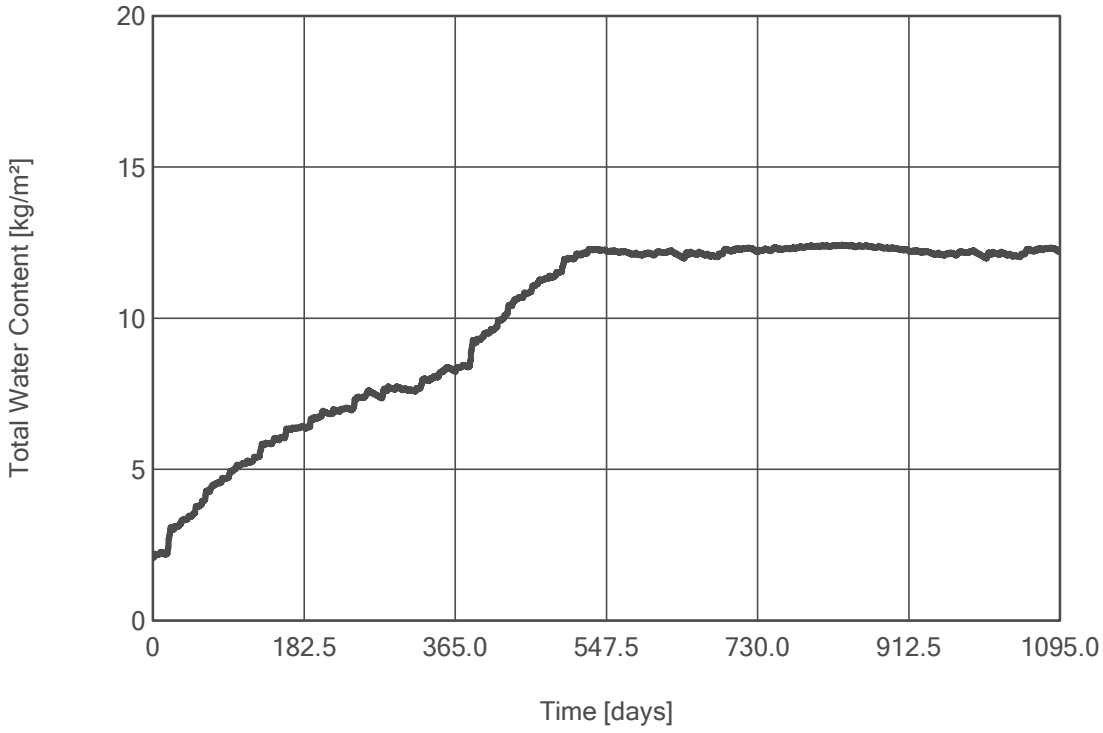
Water Content of Individual Materials



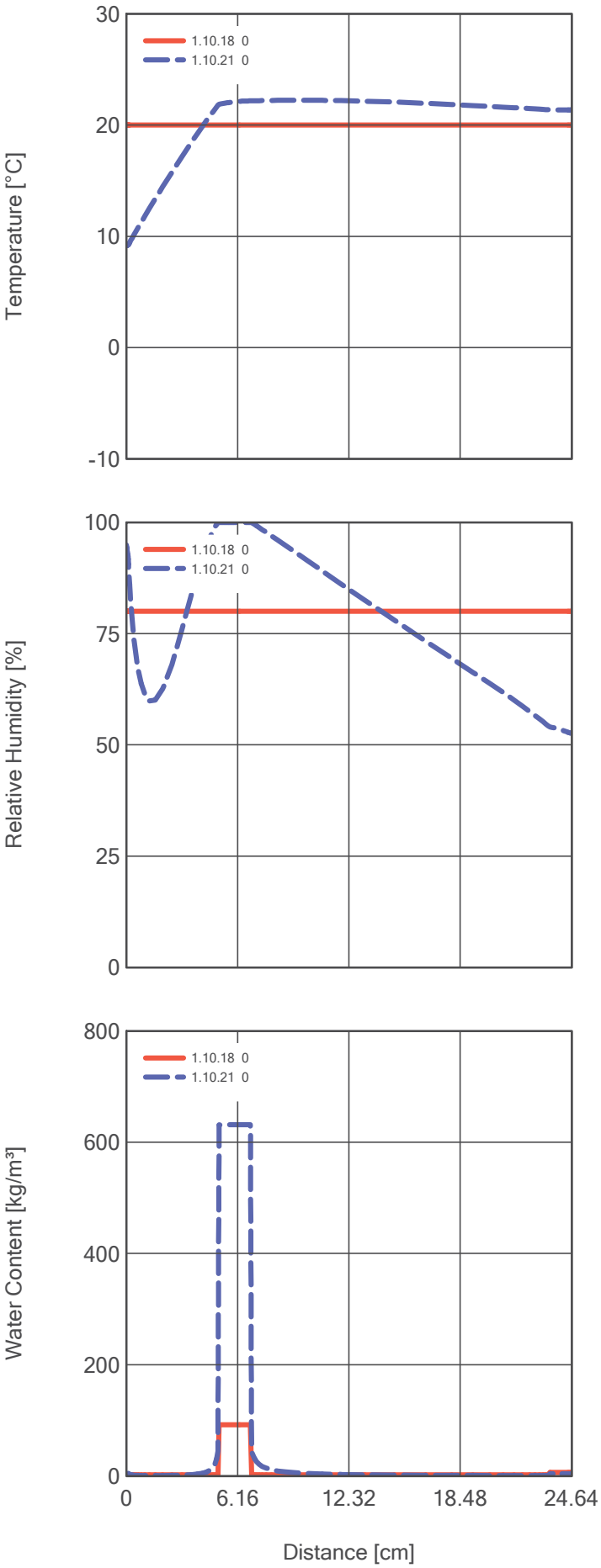
Water Content of Individual Materials



Total Water Content in Construction



Profiles

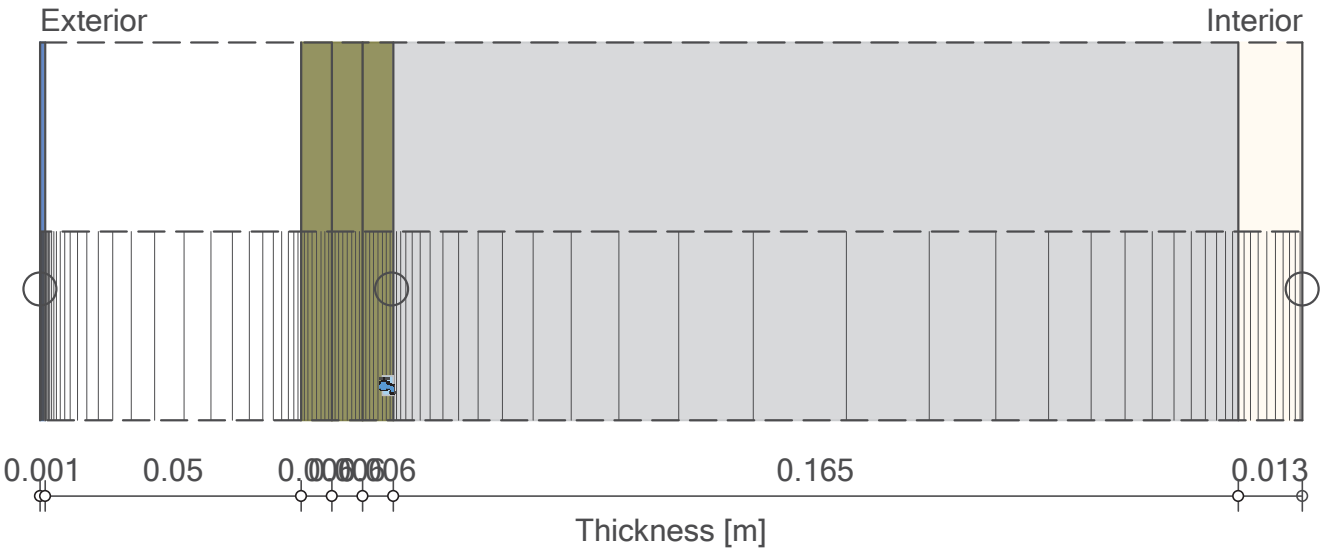

Temperature [°C]
30
20
10
0
-10
1.10.18 0
1.10.21 0
Relative Humidity [%]
100
75
50
25
0
1.10.18 0
1.10.21 0
Water Content [kg/m³]
800
600
400
200
0
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: #6 North Pitched Roof , medium moisture load , 10ACH, WET OSB



- Monitor positions

- Heat/Moisture source/sink positions

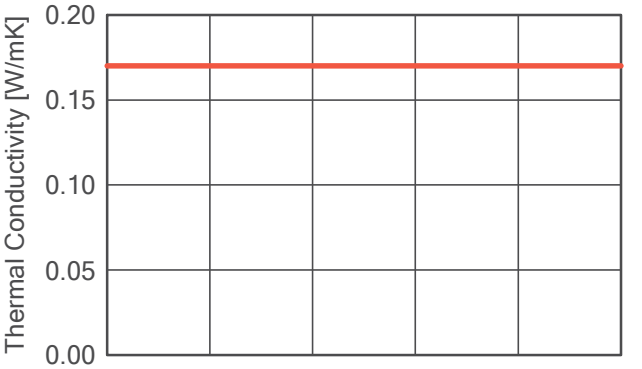
Materials:

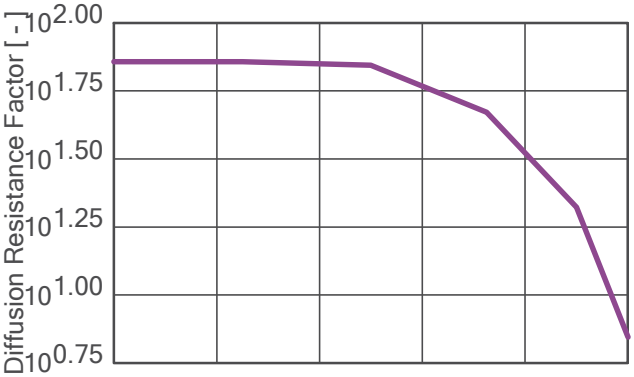
- *SOLITEX PLUS	0.001 m
- *ACME White EPS 100	0.05 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *Smartply OSB3	0.006 m
- *ACME EPS Silver 70	0.165 m
- Gypsum Board	0.013 m

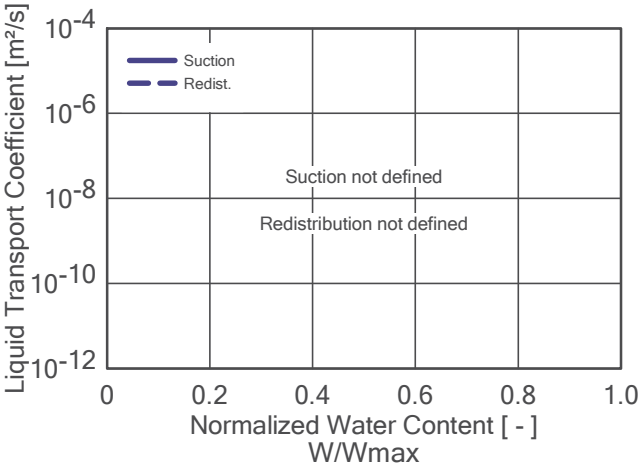
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

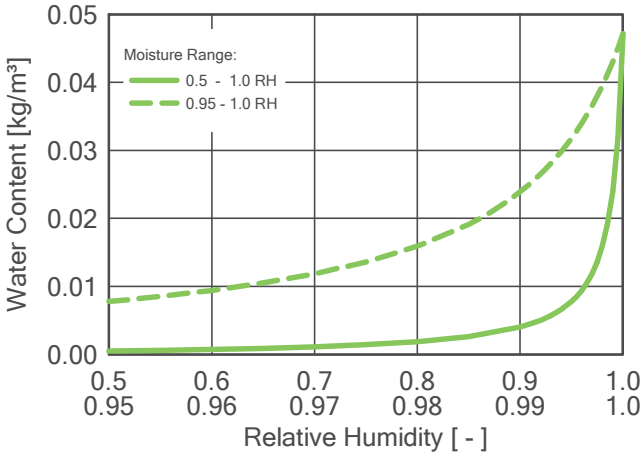
Material: *SOLITEX PLUS

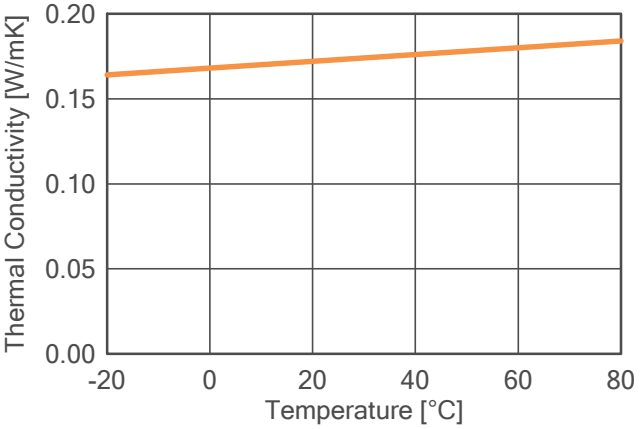
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





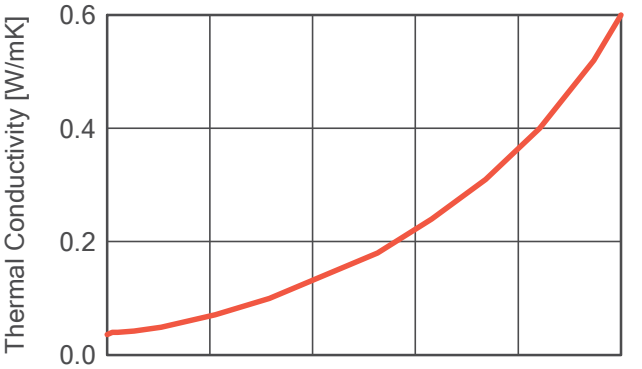


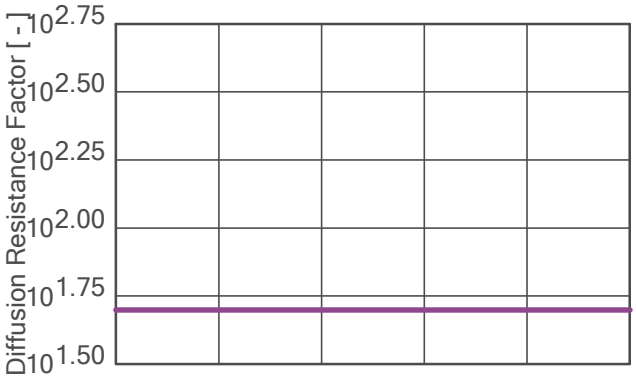


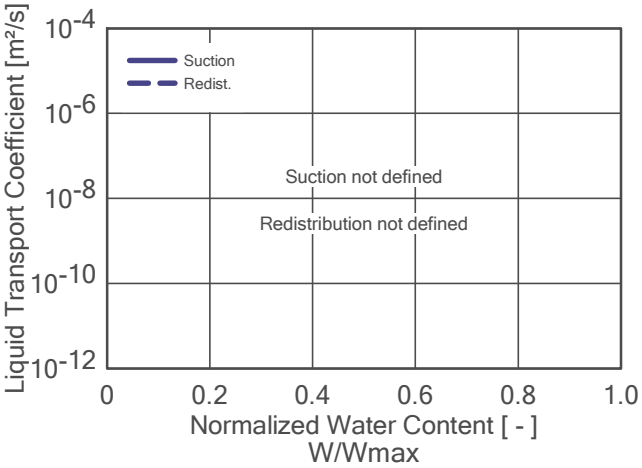


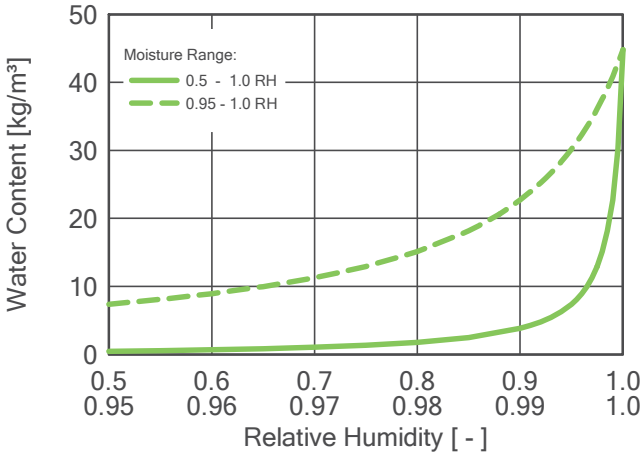
Material: *ACME White EPS 100

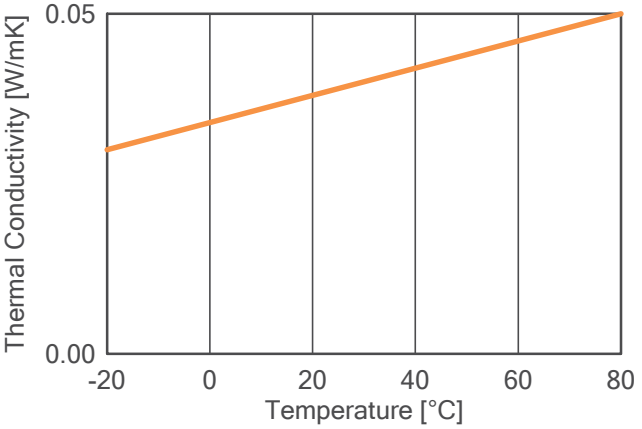
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





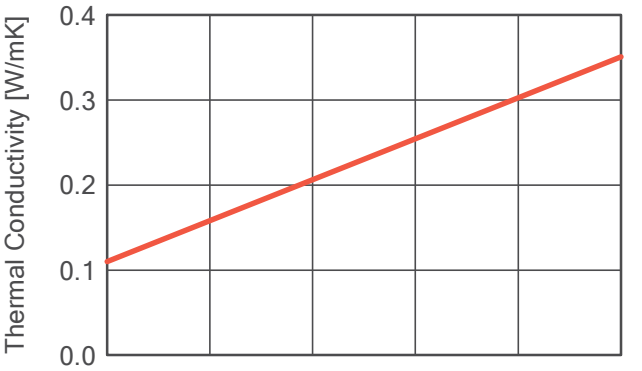


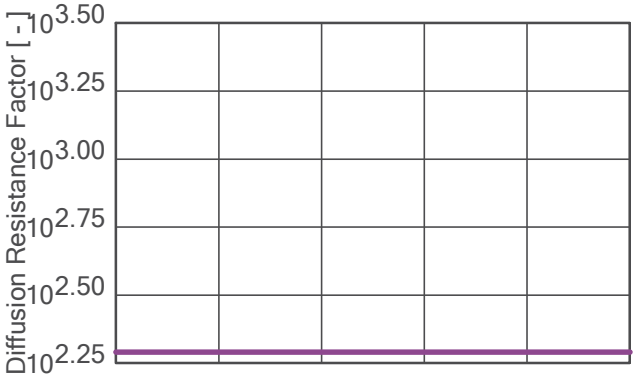


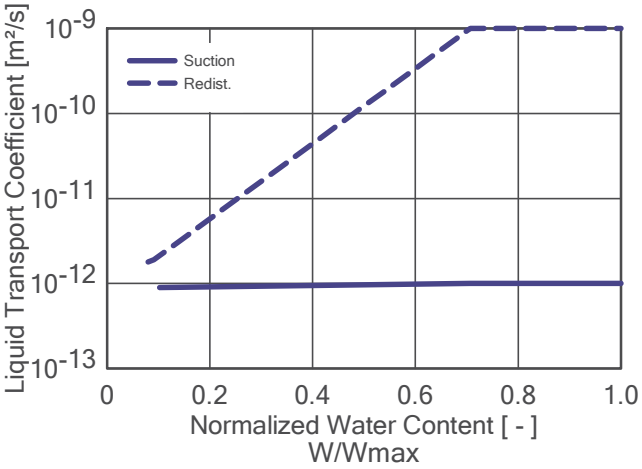


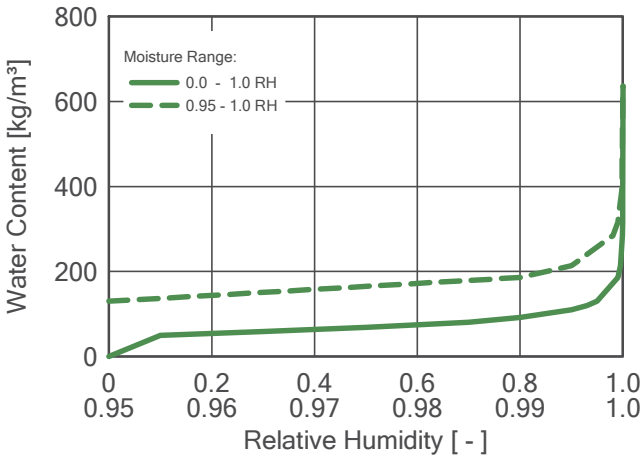
Material: *Smartply OSB3

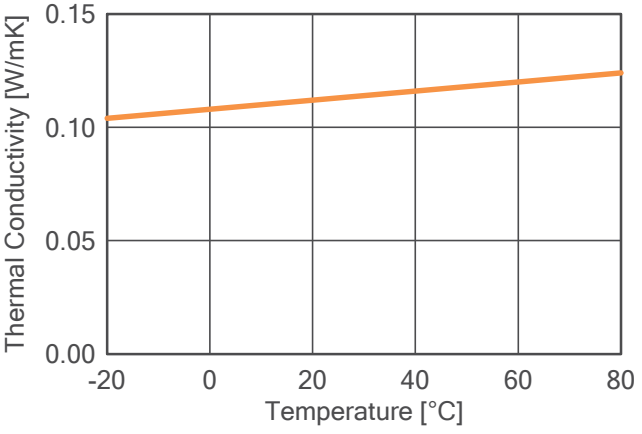
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





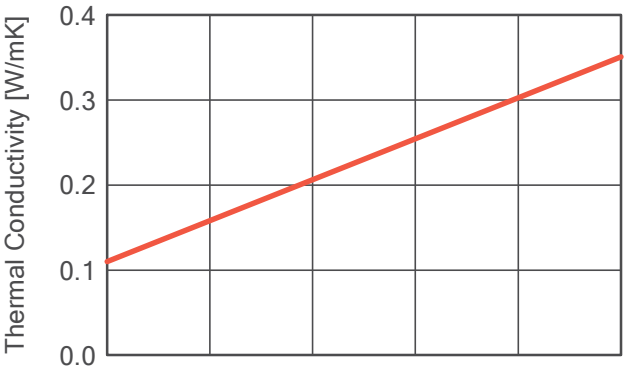


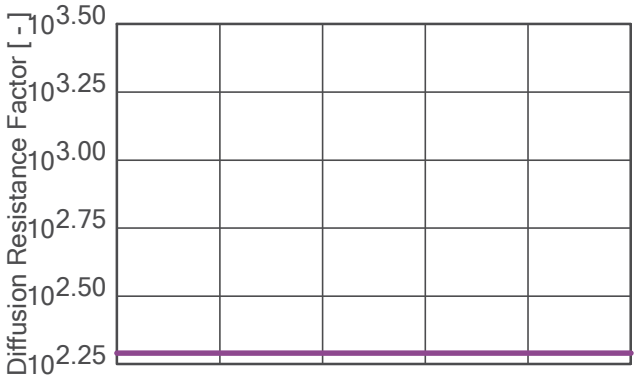


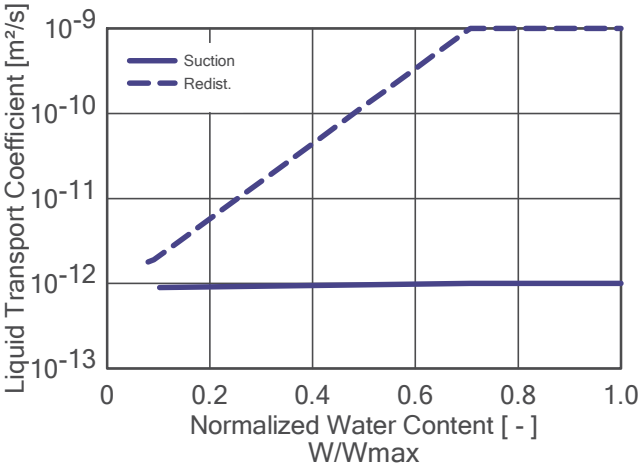


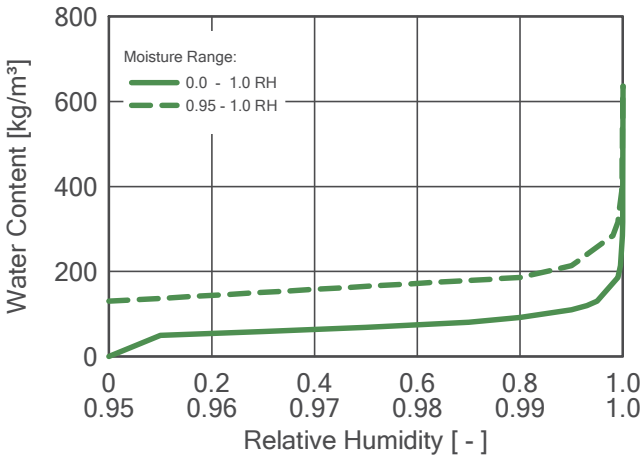
Material: *Smartply OSB3

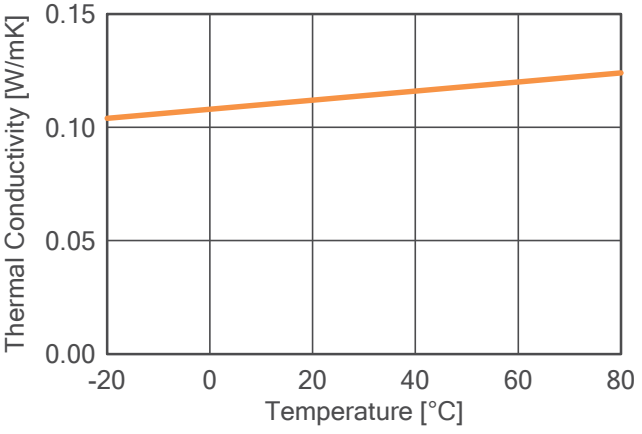
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





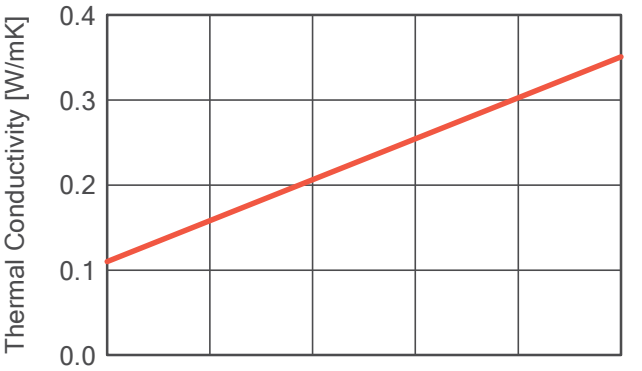


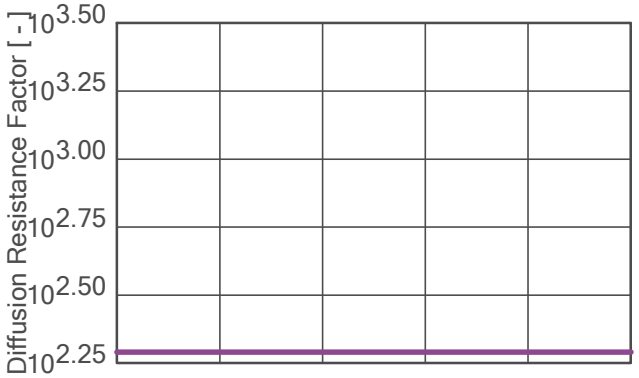


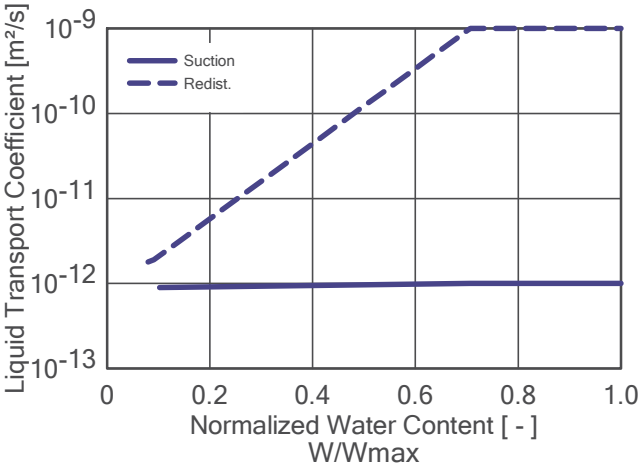


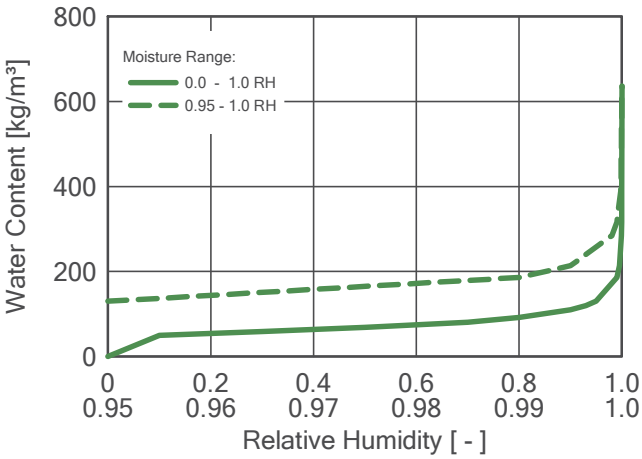
Material: *Smartply OSB3

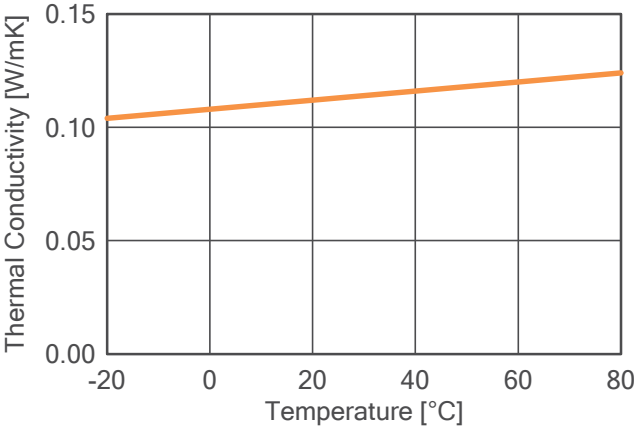
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





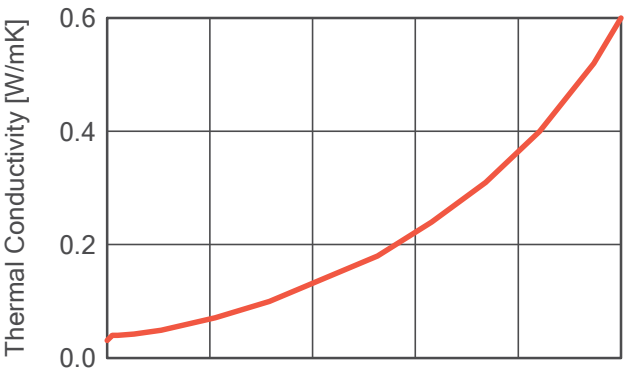


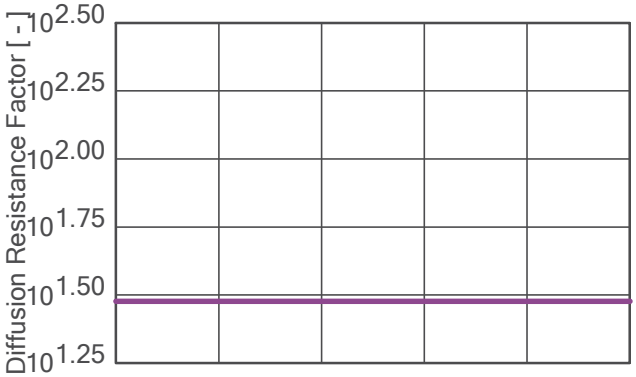


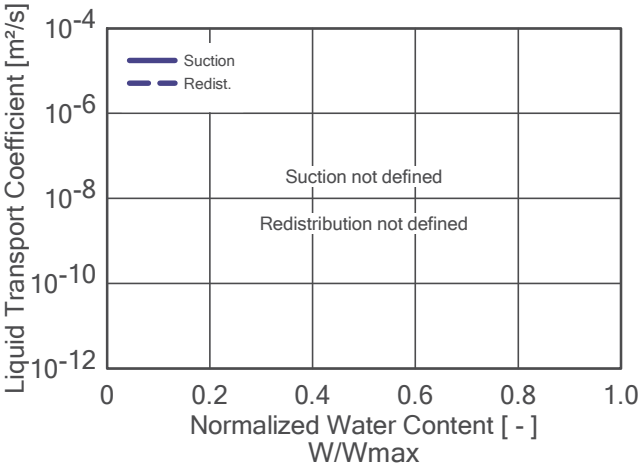


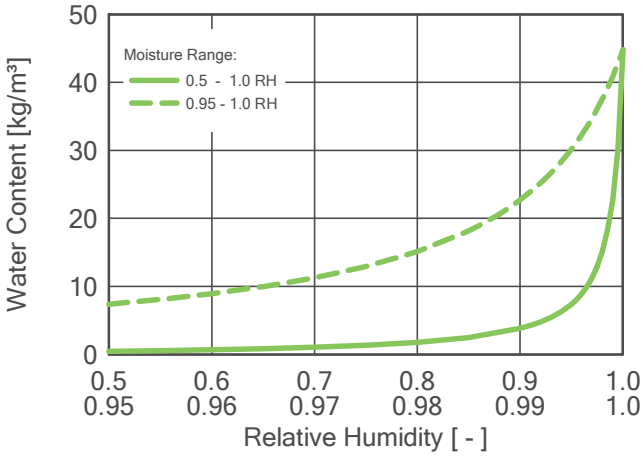
Material: *ACME EPS Silver 70

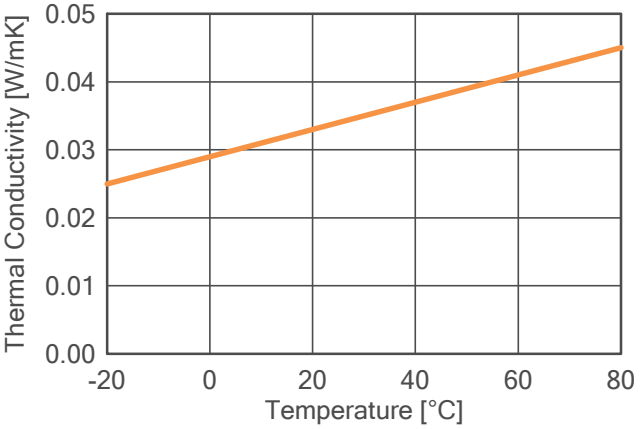
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





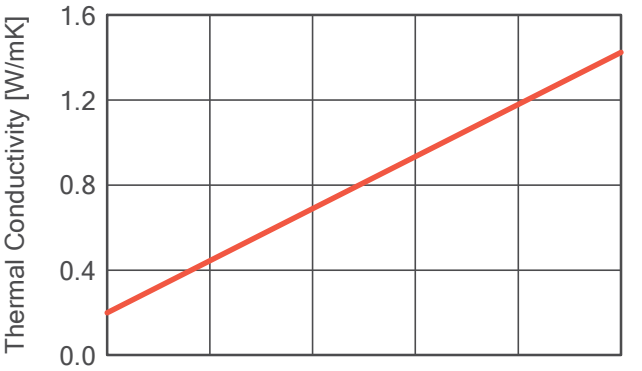


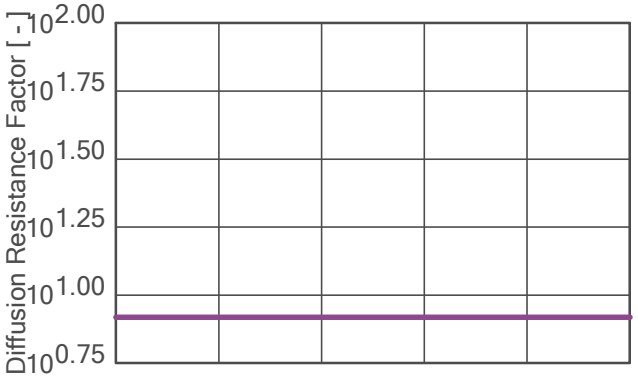


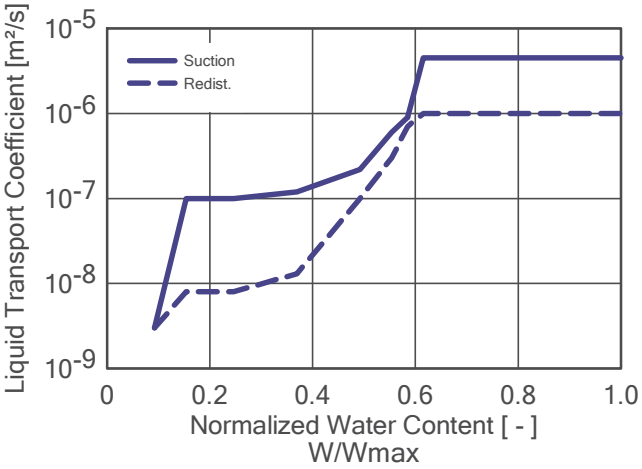


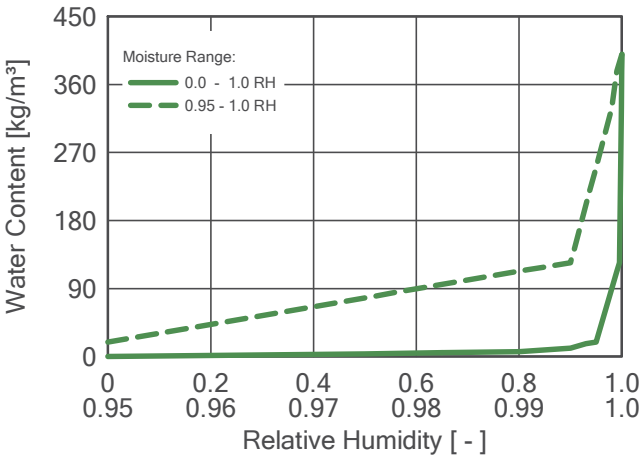
Material: Gypsum Board

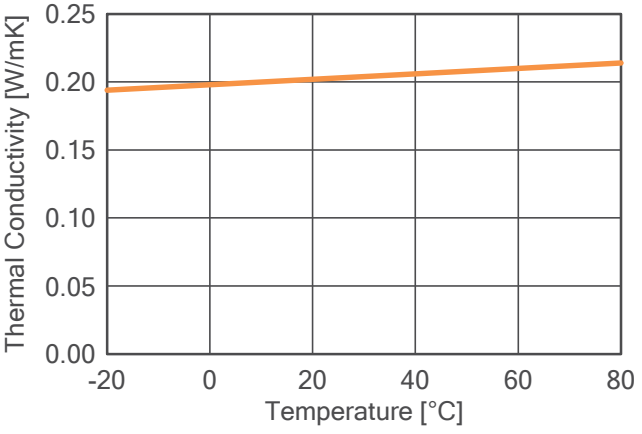
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	North / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 Medium Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	29/05/2018 15:23:51
Computing Time	0 min,34 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	2

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -1.93
Integral of fluxes, right side (kr,dr)	[kg/m²]	7.3E-8 0.51
Balance 1	[kg/m²]	-2.39
Balance 2	[kg/m²]	-2.42

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	4.06	1.67	1.55	4.06

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.18
*ACME White EPS 100	1.79	1.67	0.32	7.52
*Smartply OSB3	200.00	79.50	73.81	200.00
*Smartply OSB3	200.00	78.70	75.72	200.00
*Smartply OSB3	200.00	78.85	75.98	200.00
*ACME EPS Silver 70	1.79	0.70	0.66	2.13
Gypsum Board	6.30	3.97	2.85	6.30

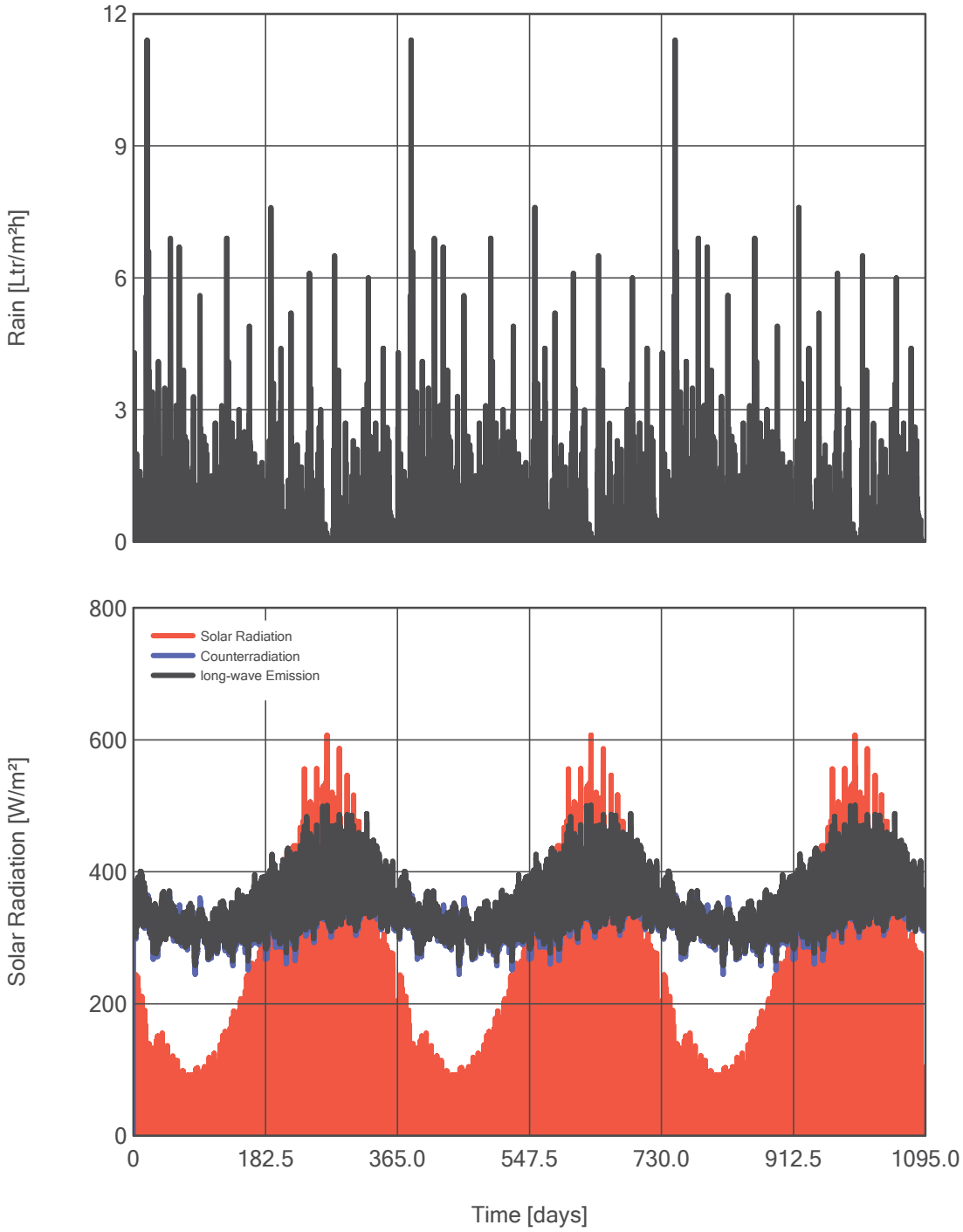
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-1724.88
Heat Flux, right side	[MJ/m²]	-126.08
Moisture Fluxes, left side	[kg/m²]	29.97
Moisture Fluxes, right side	[kg/m²]	0.51

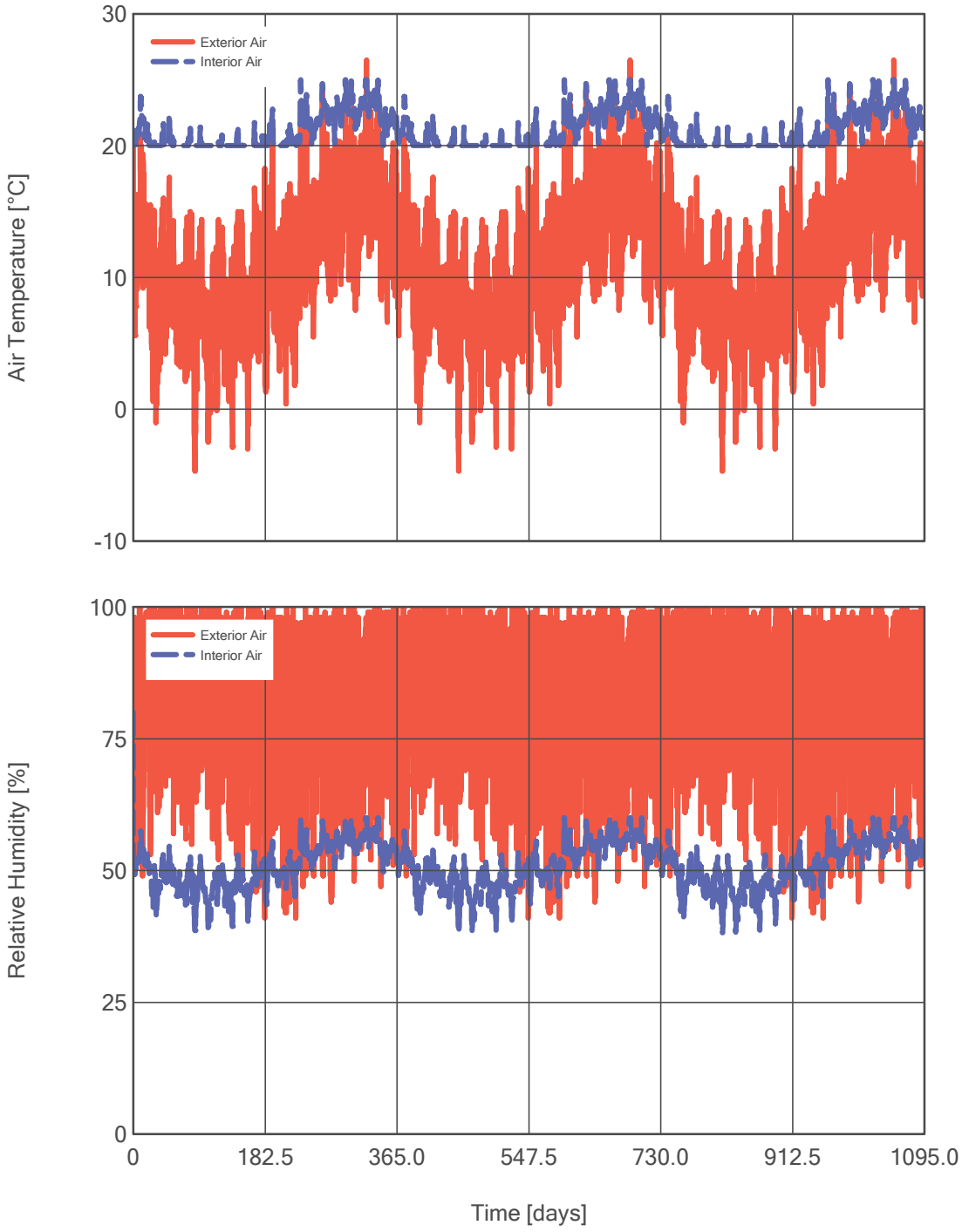
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.019
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.019

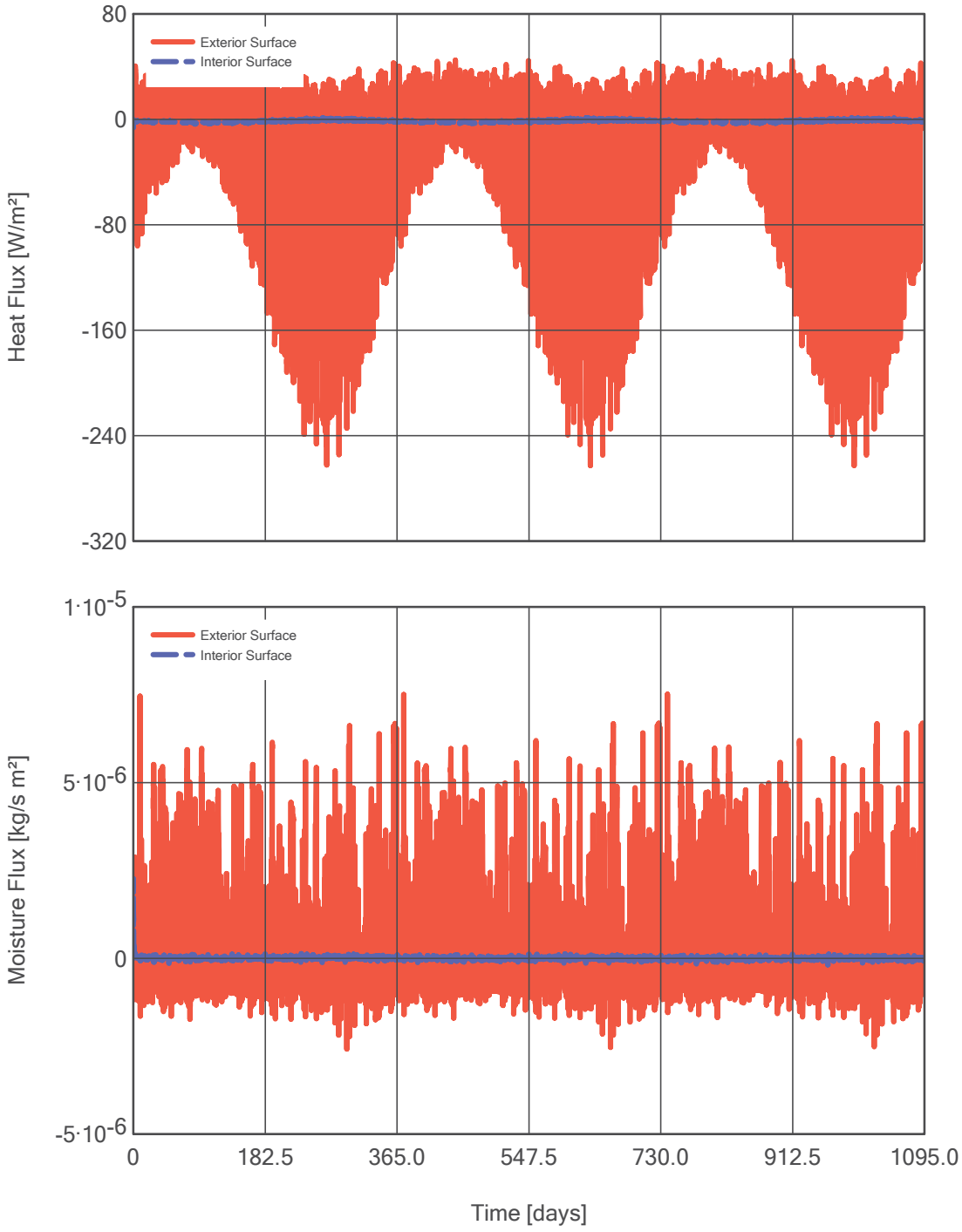
Rain, Radiation (Exterior Climate)



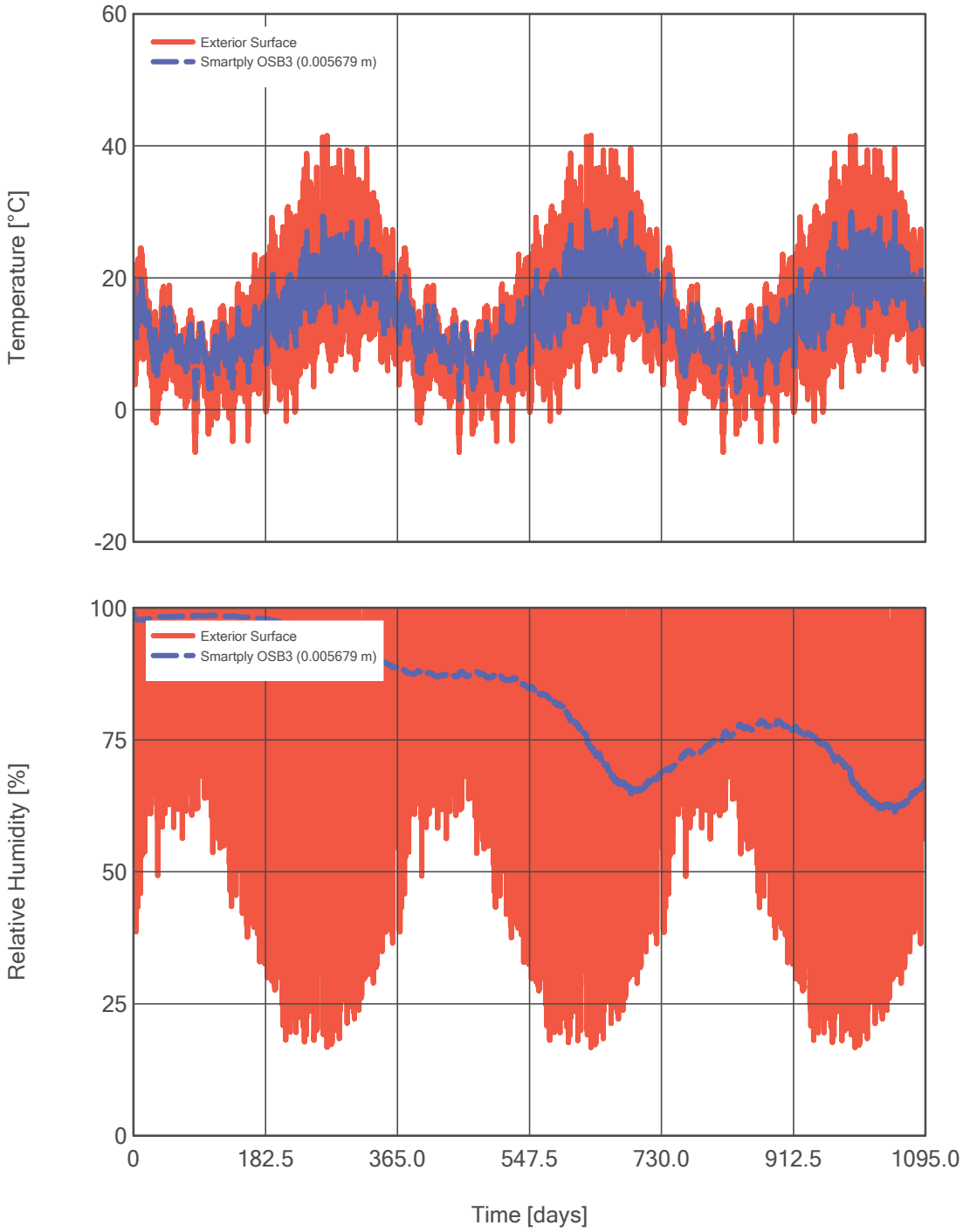
Air Temperature, RH (Exterior, Interior)



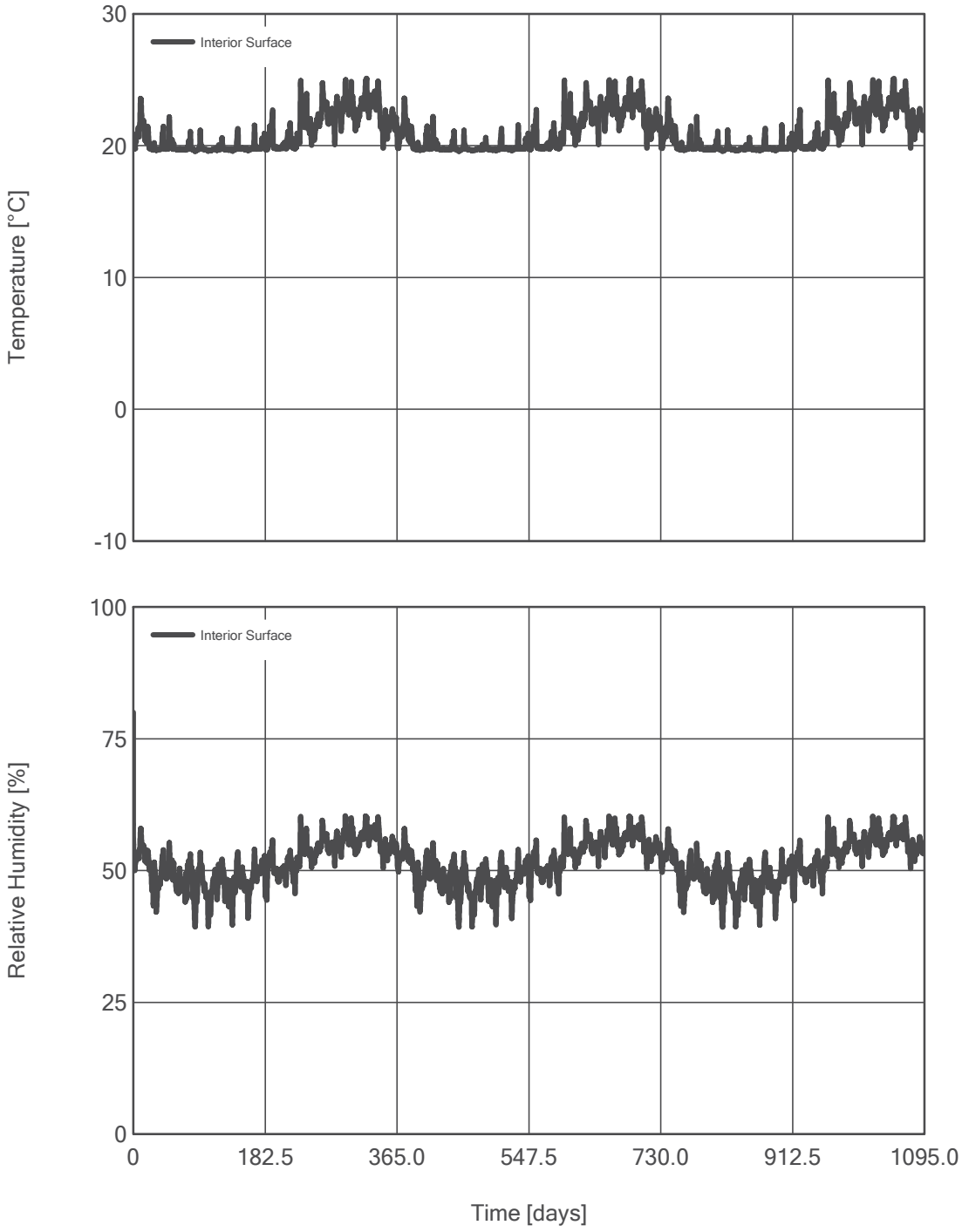
Heat, Moisture Fluxes



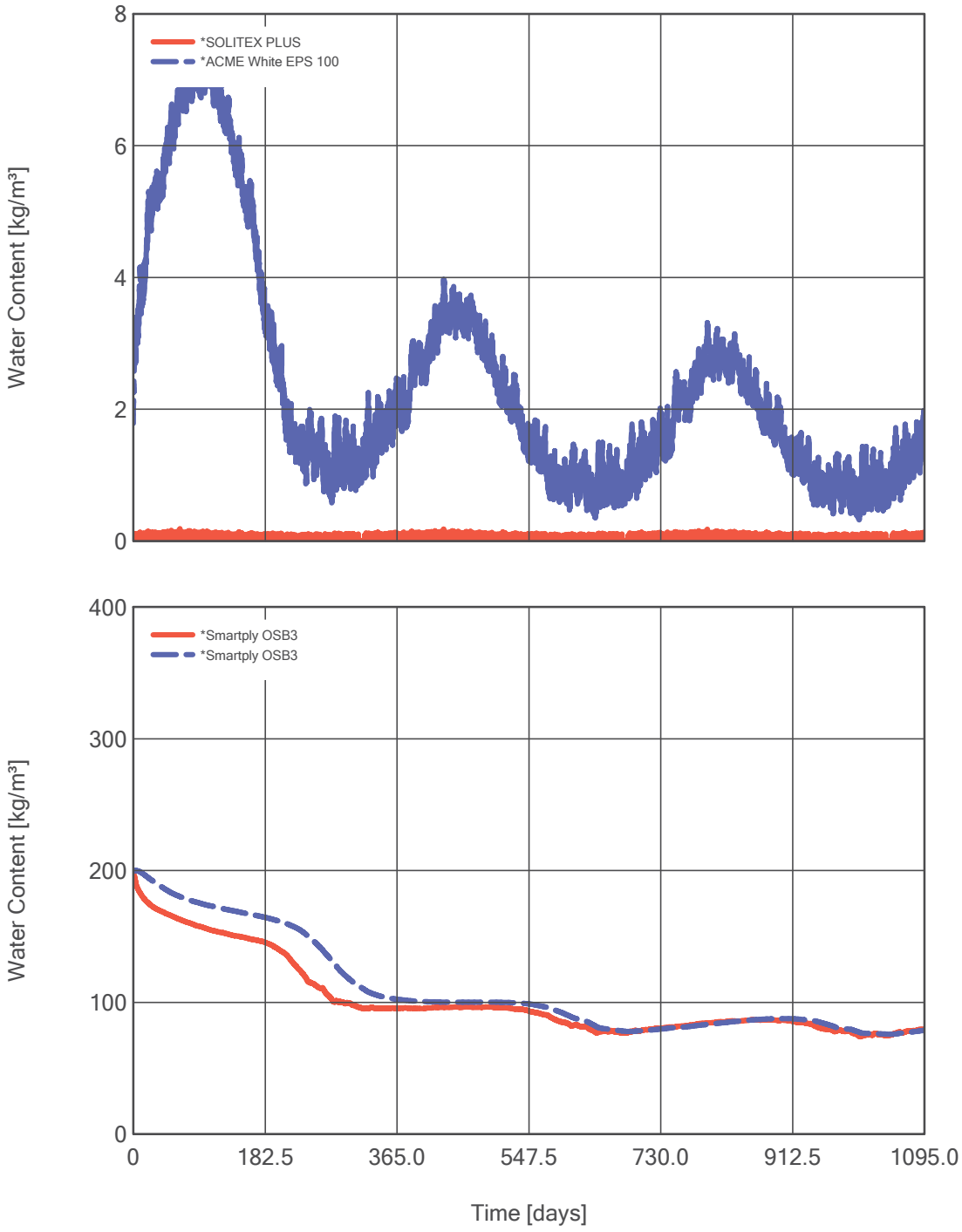
Temperature, RH (Monitor Position 1, 2)



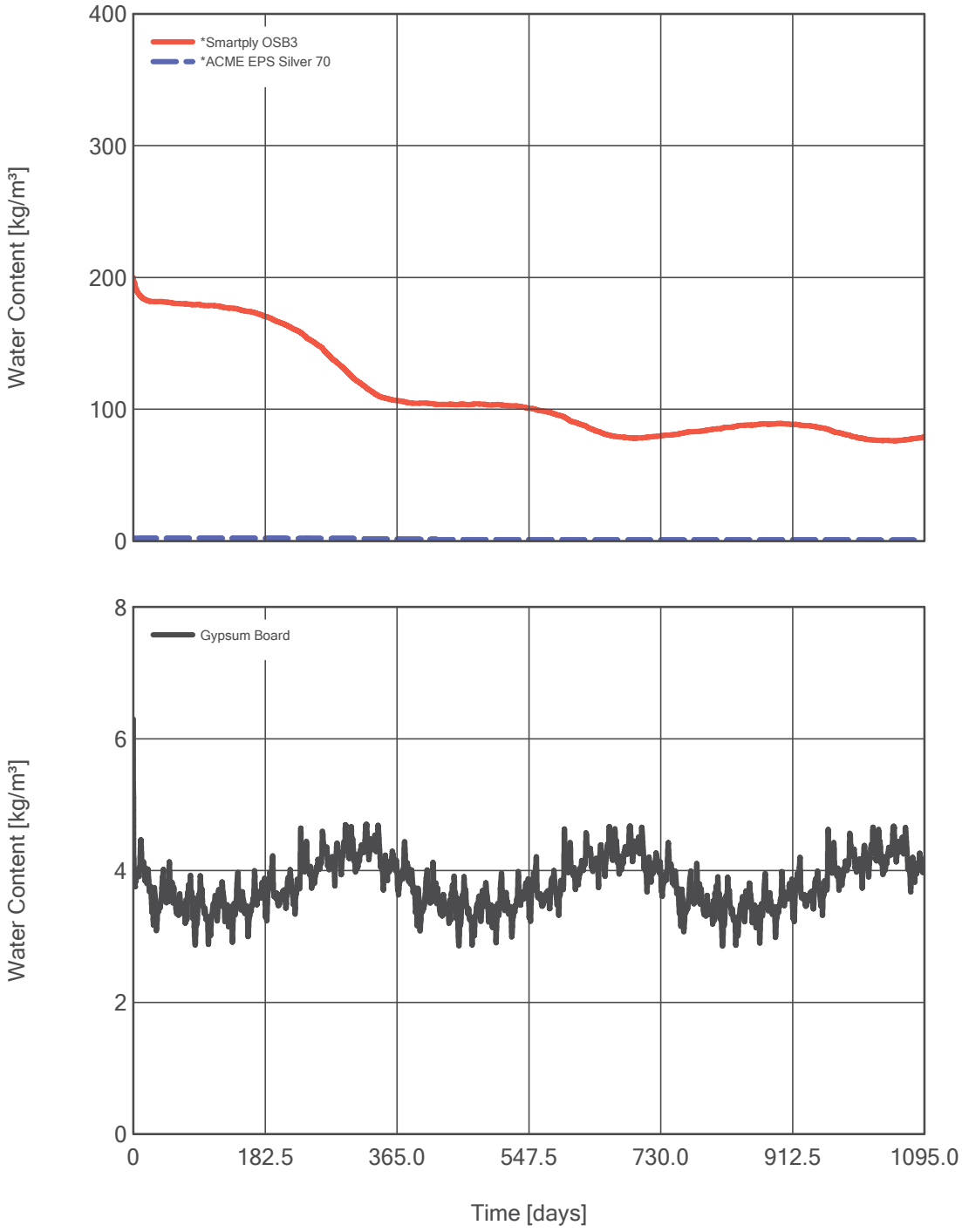
Temperature, RH (Monitor Position 3)



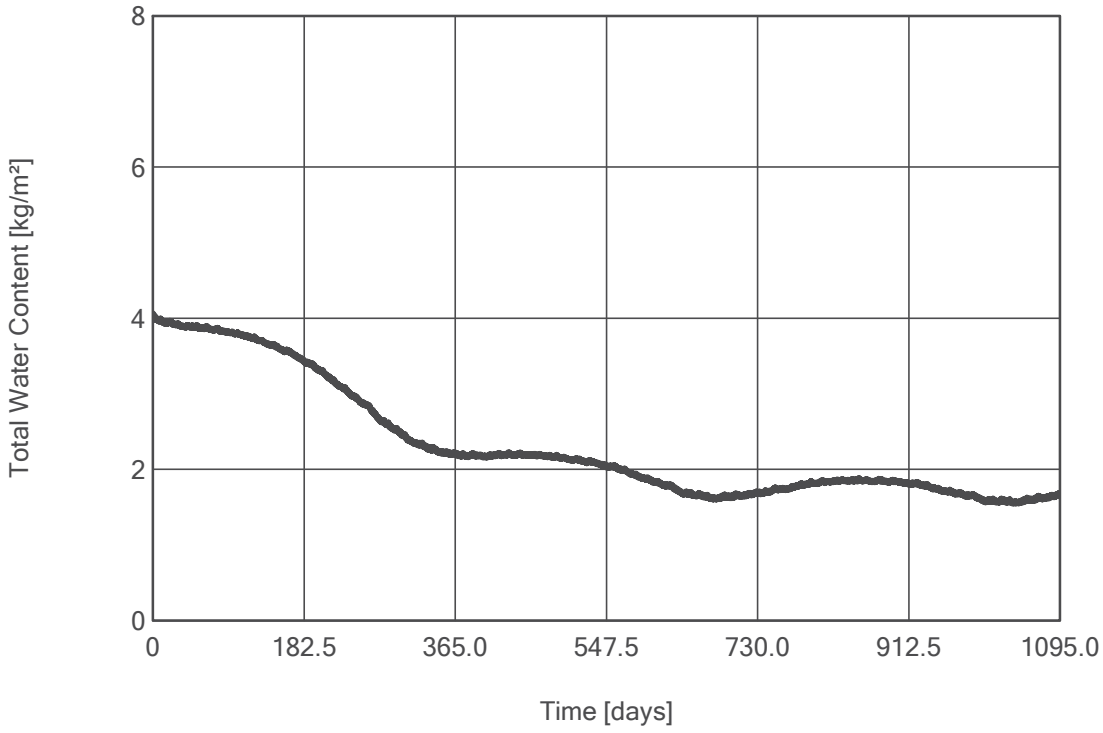
Water Content of Individual Materials



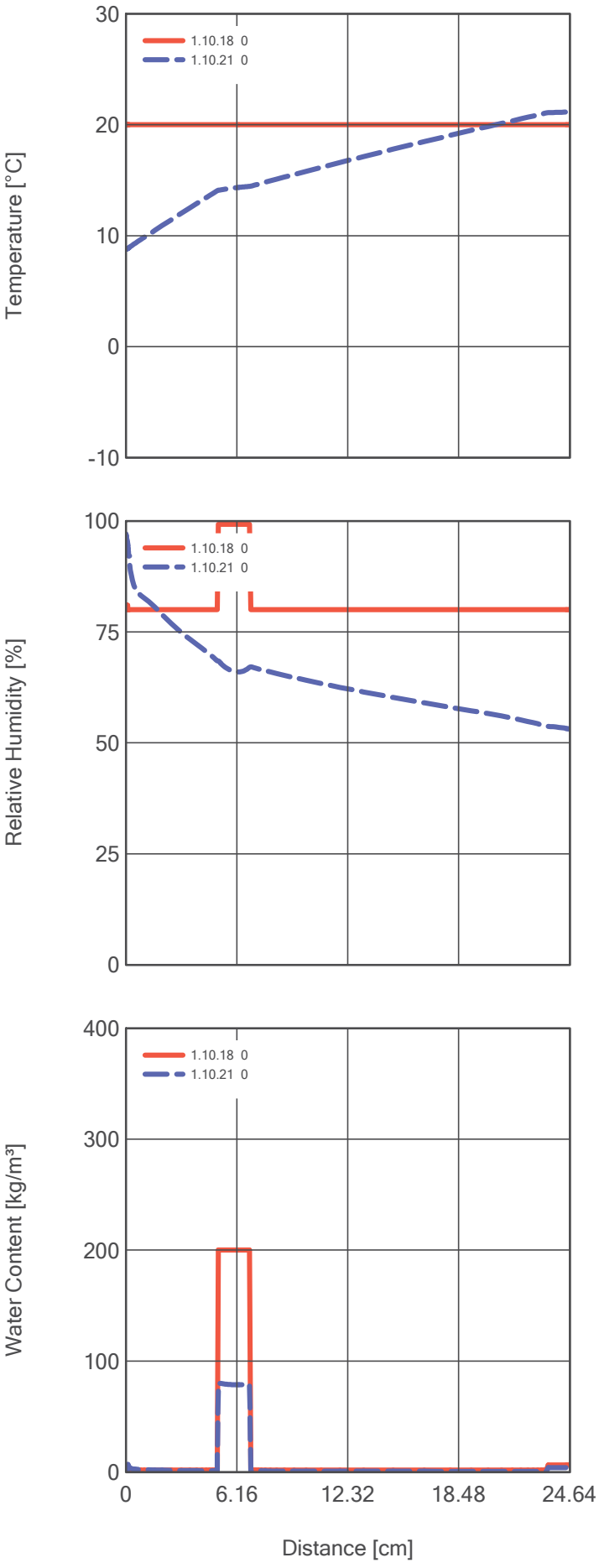
Water Content of Individual Materials



Total Water Content in Construction



Profiles

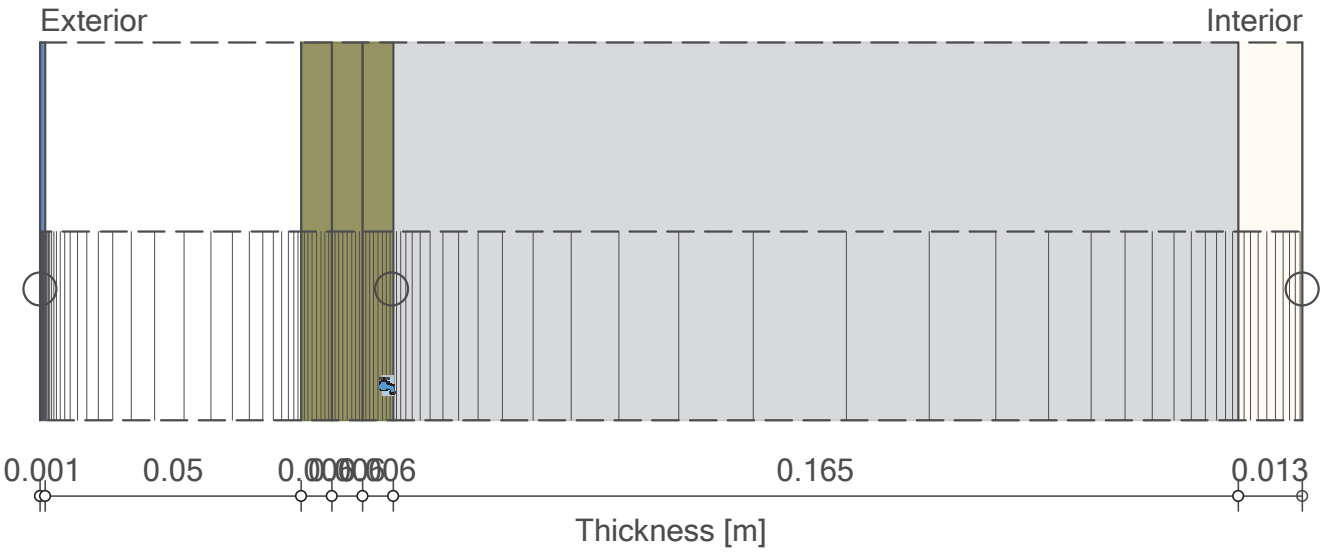

30
20
10
0
-10
Temperature [°C]
1.10.18 0
1.10.21 0
100
75
50
25
0
Relative Humidity [%]
1.10.18 0
1.10.21 0
400
300
200
100
0
Water Content [kg/m³]
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]

Project Data

Project Name	Mr and Mrs Black Pitched Roof Assessment
Project Number	290518
Client	Mr and Mrs Black
Contact Person	Mr Michael Black
City/Zip	Askeaton, co limerick
Street	Askeaton St
Phone	098823244
Fax	
e-mail	black@black.com
Responsible	[redacted]
Remarks	Desktop Study Only. Please Note Disclaimer document.
Date	29/05/2018

Component Assembly

Case: North Pitched Roof , high moisture load , 10ACH, WET OSB



- Monitor positions

- Heat/Moisture source/sink positions

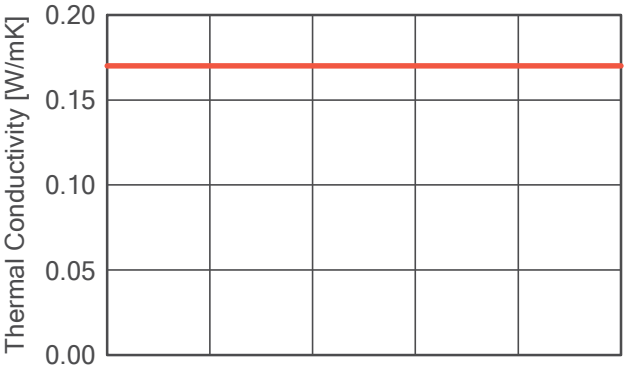
Materials:

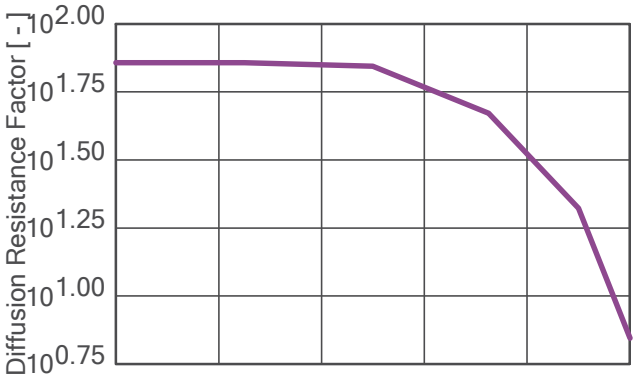
	- *SOLITEX PLUS	0.001 m
	- *ACME White EPS 100	0.05 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *Smartply OSB3	0.006 m
	- *ACME EPS Silver 70	0.165 m
	- Gypsum Board	0.013 m

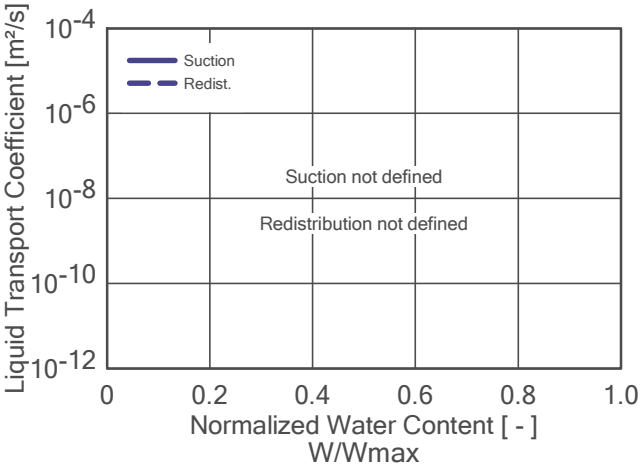
Total Thickness: 0.247 m
R-Value: 6.62 m²K/W
U-Value: 0.147 W/m²K

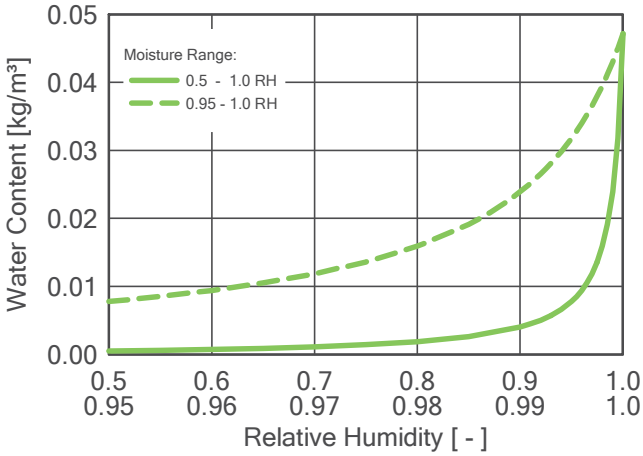
Material: *SOLITEX PLUS

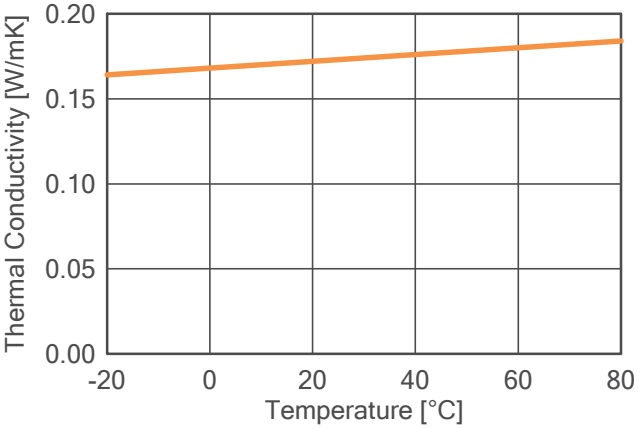
Property	Unit	Value
Bulk density	[kg/m³]	275.0
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/kgK]	1000.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.17
Water Vapour Diffusion Resistance Factor	[-]	72.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





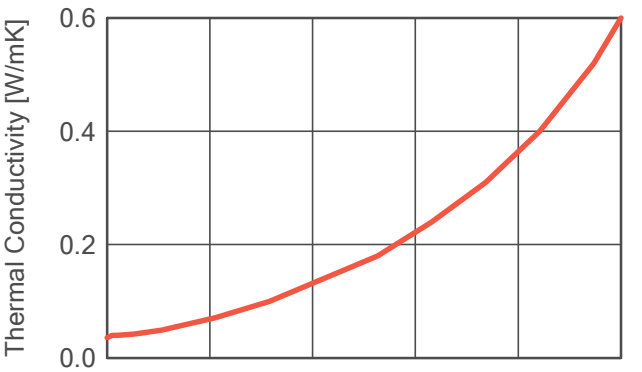


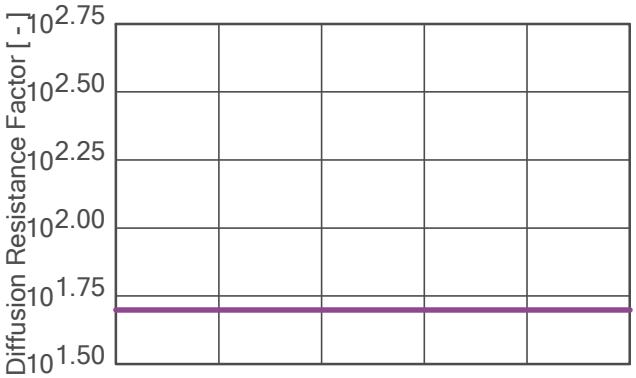


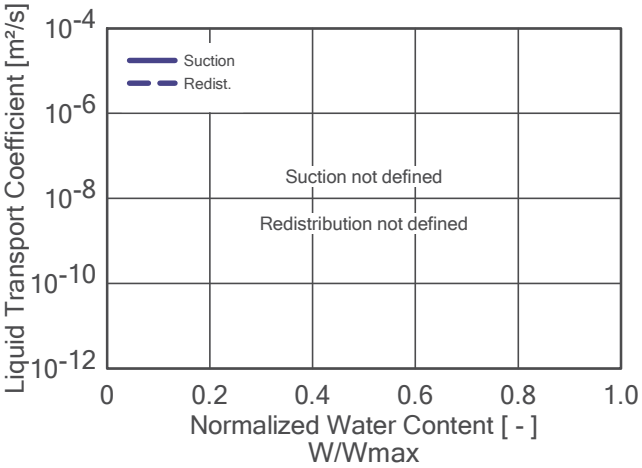


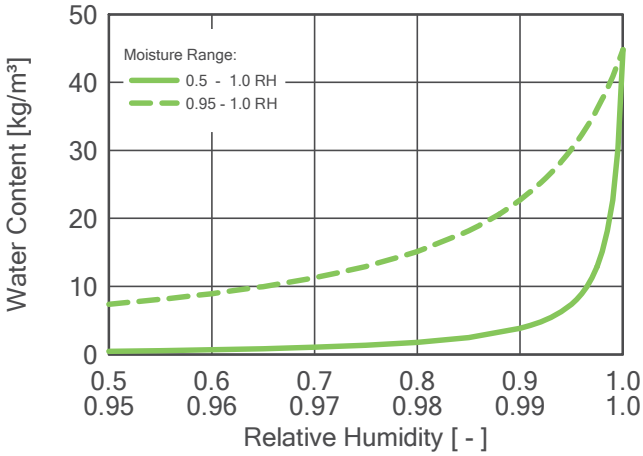
Material: *ACME White EPS 100

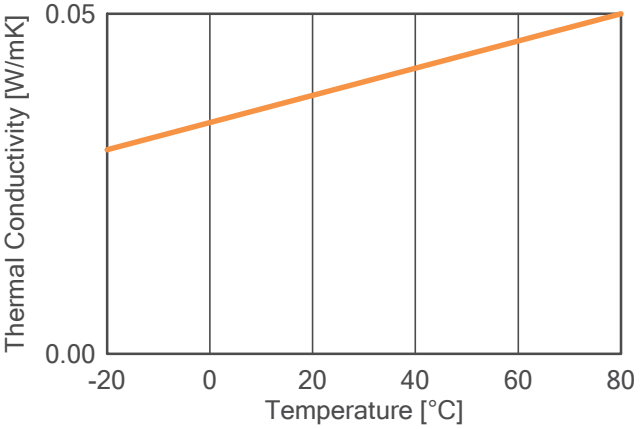
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.036
Water Vapour Diffusion Resistance Factor	[-]	50.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





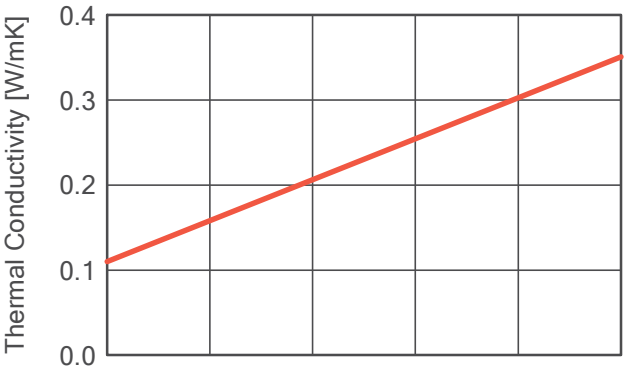


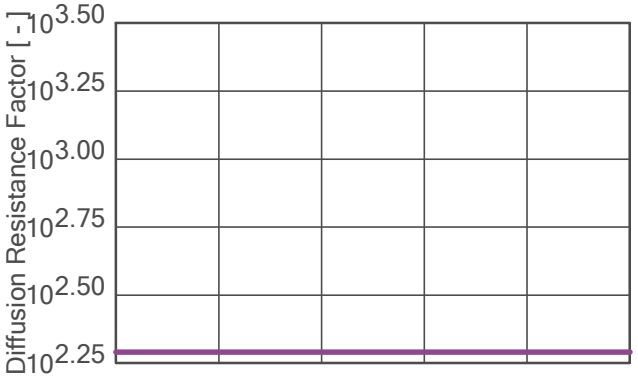


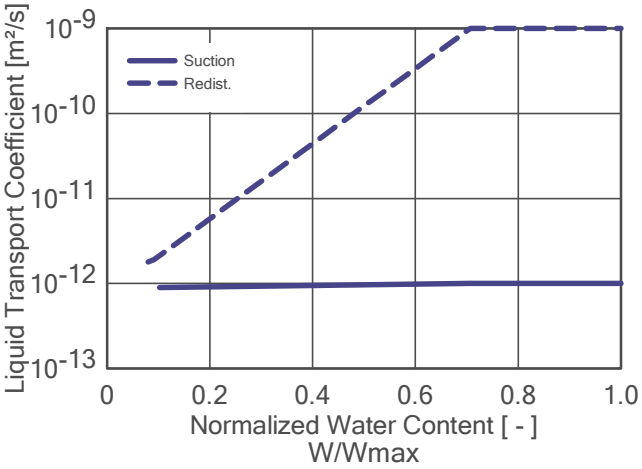


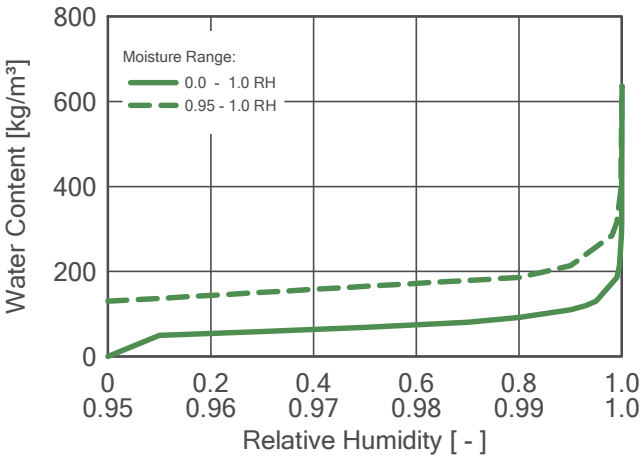
Material: *Smartply OSB3

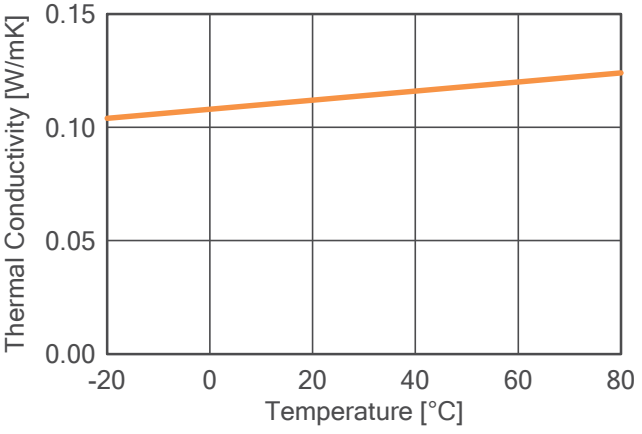
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





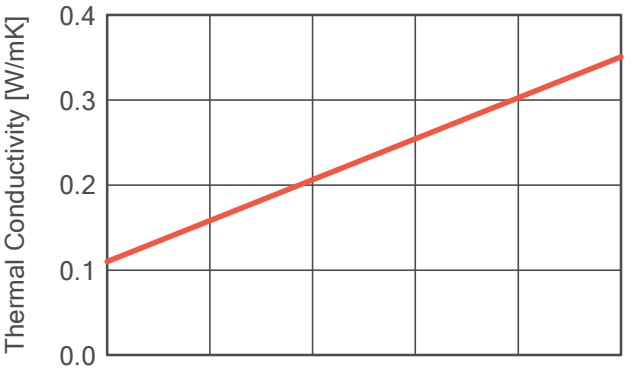


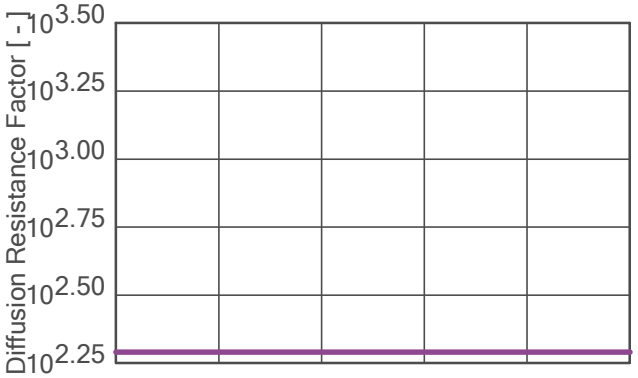


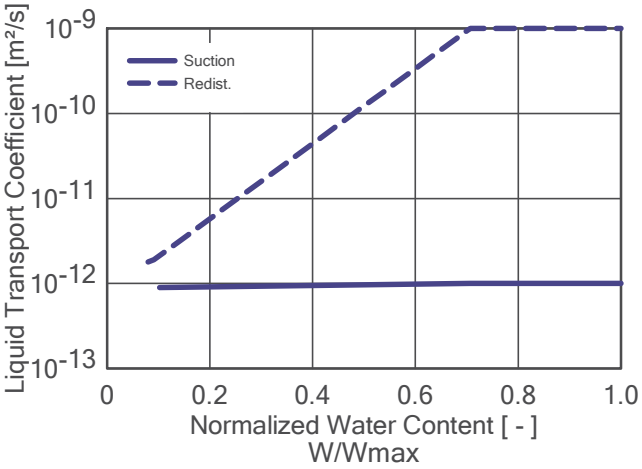


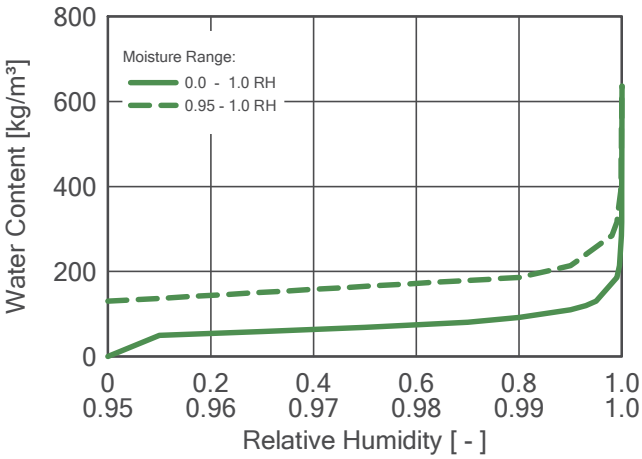
Material: *Smartply OSB3

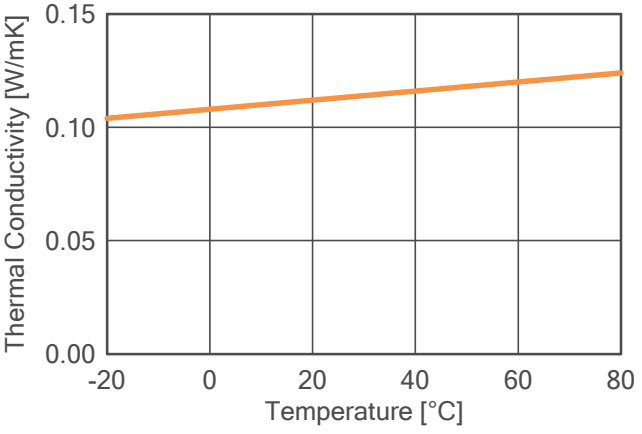
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





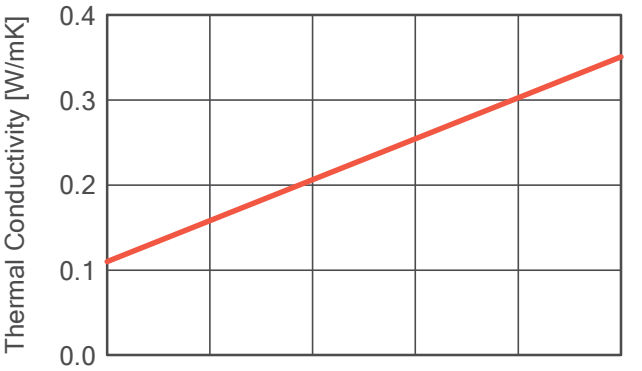


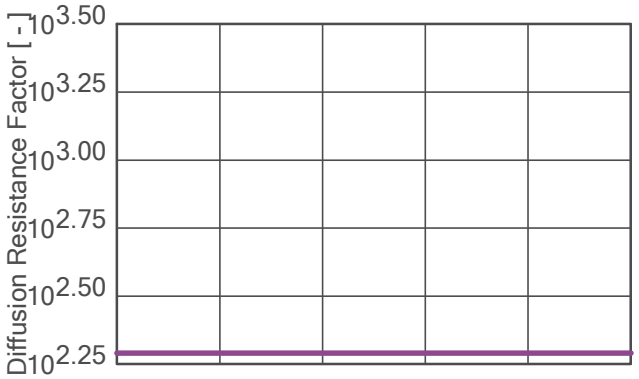


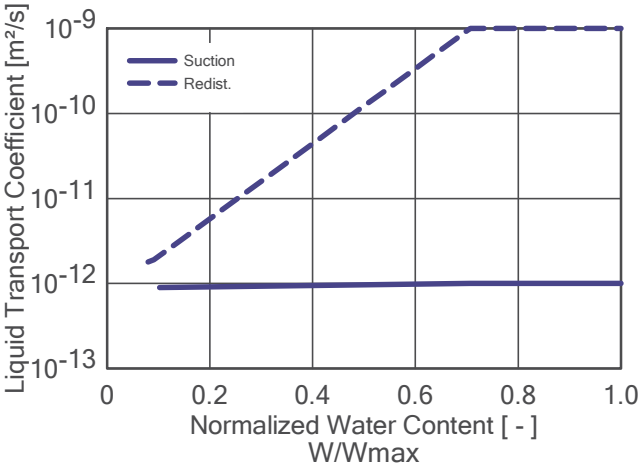


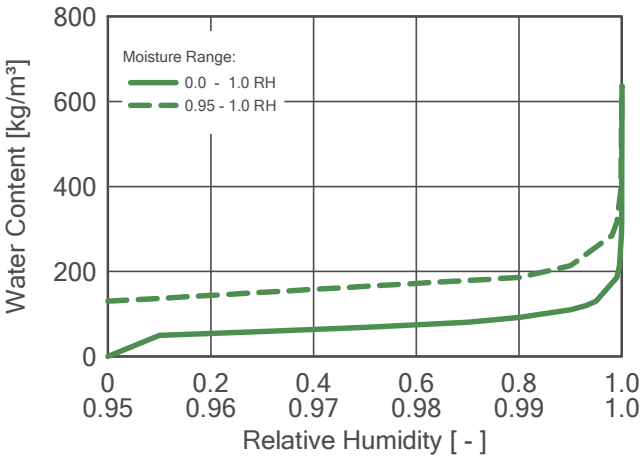
Material: *Smartply OSB3

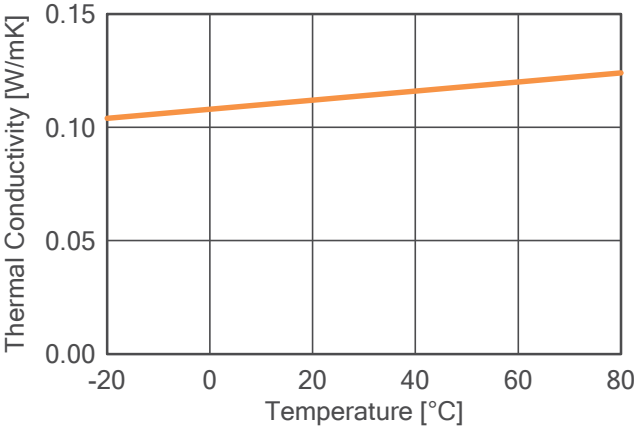
Property	Unit	Value
Bulk density	[kg/m³]	615.0
Porosity	[m³/m³]	0.9
Specific Heat Capacity, Dry	[J/kgK]	1700.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.11
Water Vapour Diffusion Resistance Factor	[-]	195.0
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.5
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





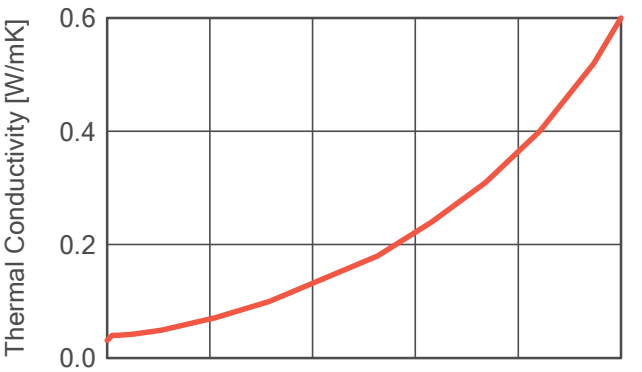


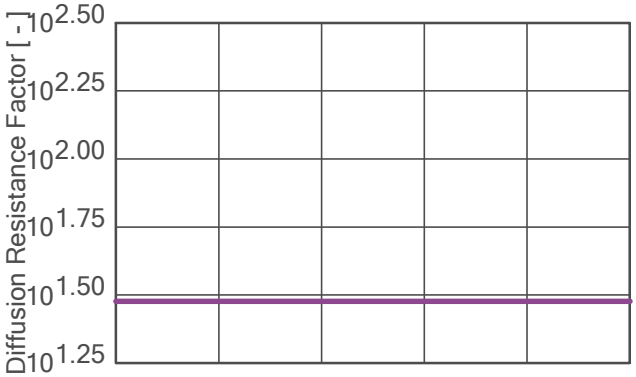


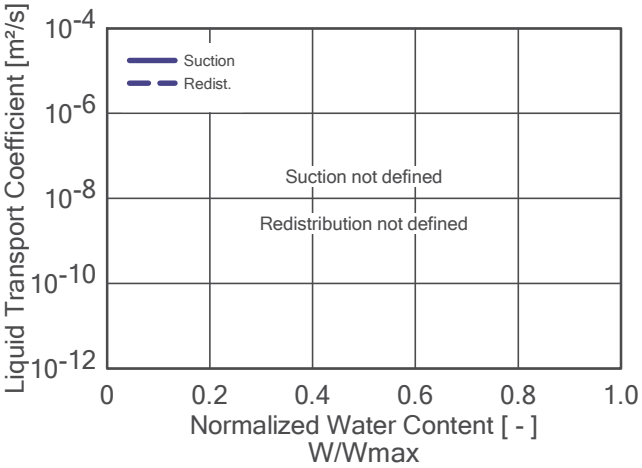


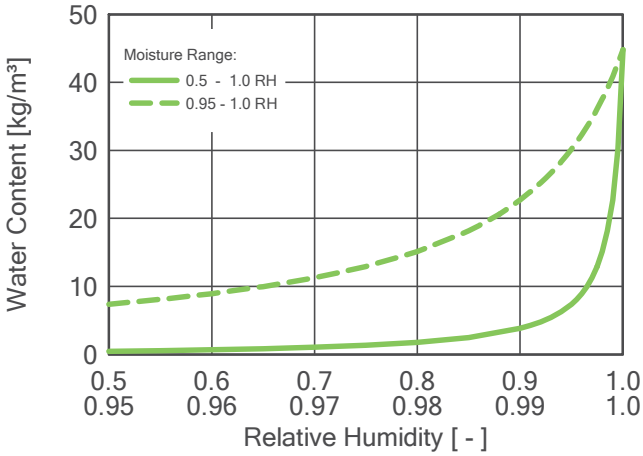
Material: *ACME EPS Silver 70

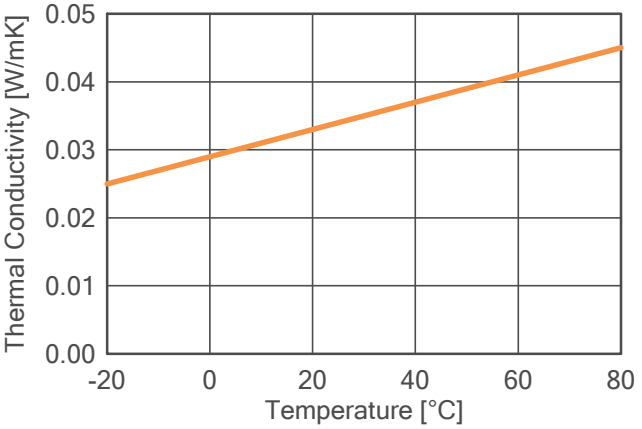
Property	Unit	Value
Bulk density	[kg/m³]	15.0
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/kgK]	1500.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.031
Water Vapour Diffusion Resistance Factor	[-]	30.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002





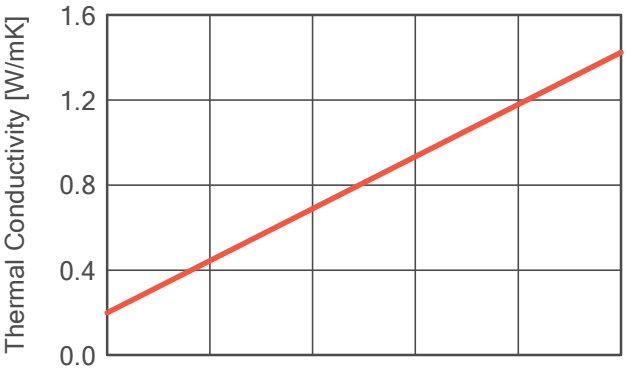


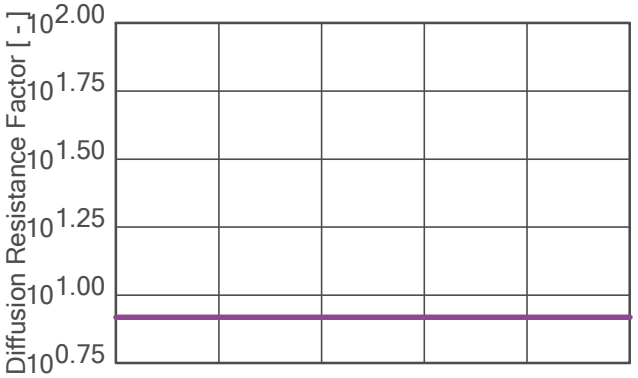


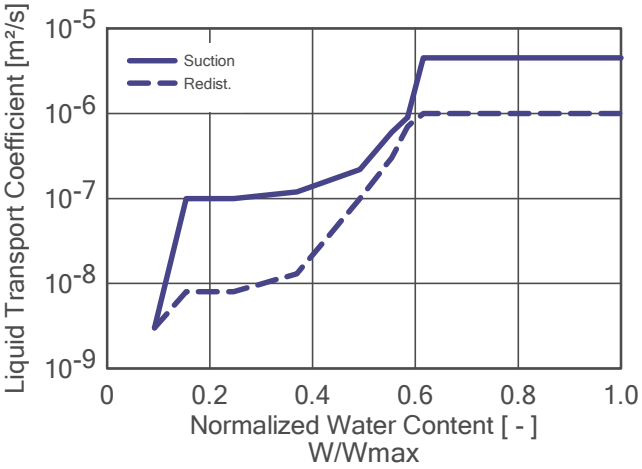


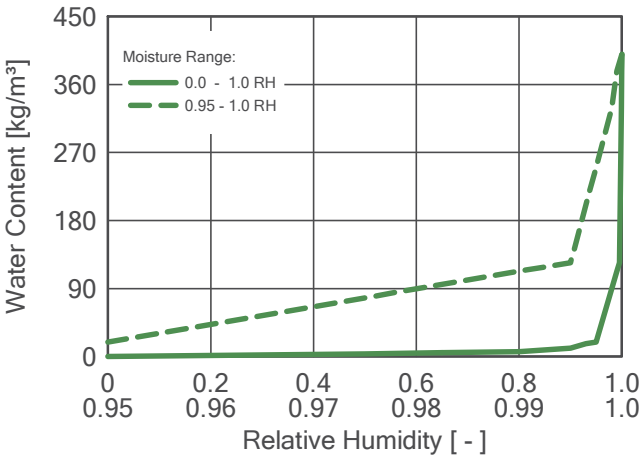
Material: Gypsum Board

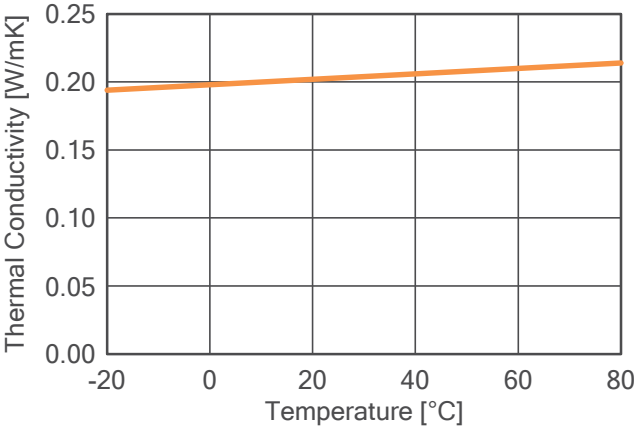
Property	Unit	Value
Bulk density	[kg/m³]	850.0
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/kgK]	850.0
Thermal Conductivity, Dry, 10°C	[W/mK]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8.0
Temp-dep. Thermal Cond. Supplement	[W/mK²]	0.0002











Boundary Conditions

Exterior (Left Side)

Location:	ShannonAirport_extreme.wac
Temperature Shift:	0 °C
Orientation / Inclination:	North / 35 °
Nighttime radiation cooling:	Explicit Radiation Balance

Interior (Right Side)

Indoor Climate:	EN 15026 High Moisture Load

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Resistance - includes long-wave radiation	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.0526 yes
Sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	Dark	[-]	0.8
Long-Wave Radiation Emissivity	Dark	[-]	0.9
Adhering Fraction of Rain	No absorption	[-]	----
Explicit Radiation Balance			yes
Terrestrial Short-Wave Reflectivity		[-]	0.2
Terrestrial Long-Wave Emissivity		[-]	0.9
Terrestrial Long-Wave Reflectivity		[-]	0.1
Cloud Index		[-]	0.66

Interior (Right Side)

Name	Description	Unit	Value
Heat Resistance	Roof (DIN 68800-2:2012-02)	[m²K/W]	0.125
Sd-Value	No coating	[m]	----

Sources, Sinks

***Smartply OSB3**

Name	Type		
Stack5m ACH 10	*Moisture Source; Air Infiltration model IBP*		
	Start Depth in Layer	[m]	0.004
	End Depth in Layer	[m]	0.006
	Cut-Off at Free Water Saturation	[kg/m³]	636.0
	Envelope Infiltration q50	[m³/m²h]	10
	Stack Height	[m]	5
	Mechanical Ventilation Overpressure	[Pa]	0

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	30/05/2018 22:21:21
Computing Time	2 min,20 sec.
Begin / End of calculation	01/10/2018 / 01/10/2021
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -2.22
Integral of fluxes, right side (kr,dr)	[kg/m²]	1E-7 0.2
Balance 1	[kg/m²]	-2.18
Balance 2	[kg/m²]	-2.21

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	4.06	1.88	1.83	4.06

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
*SOLITEX PLUS	0.00	0.01	0.00	0.20
*ACME White EPS 100	1.79	1.73	0.48	7.34
*Smartply OSB3	200.00	84.10	81.81	200.00
*Smartply OSB3	200.00	85.44	84.82	200.00
*Smartply OSB3	200.00	87.72	86.57	200.00
*ACME EPS Silver 70	1.79	1.13	1.11	2.89
Gypsum Board	6.30	5.05	3.61	6.30

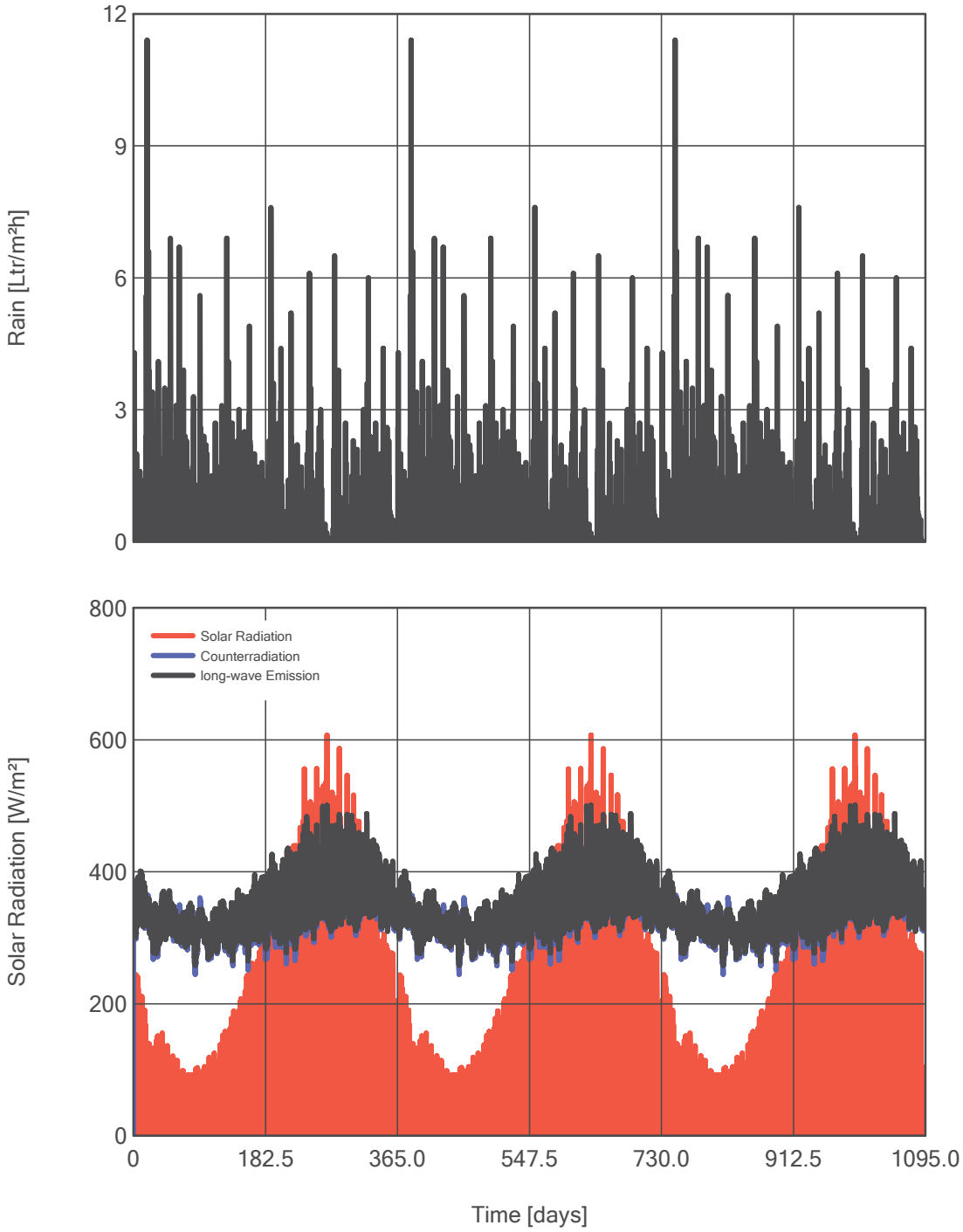
Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-1728.14
Heat Flux, right side	[MJ/m²]	-128.11
Moisture Fluxes, left side	[kg/m²]	30.66
Moisture Fluxes, right side	[kg/m²]	0.2

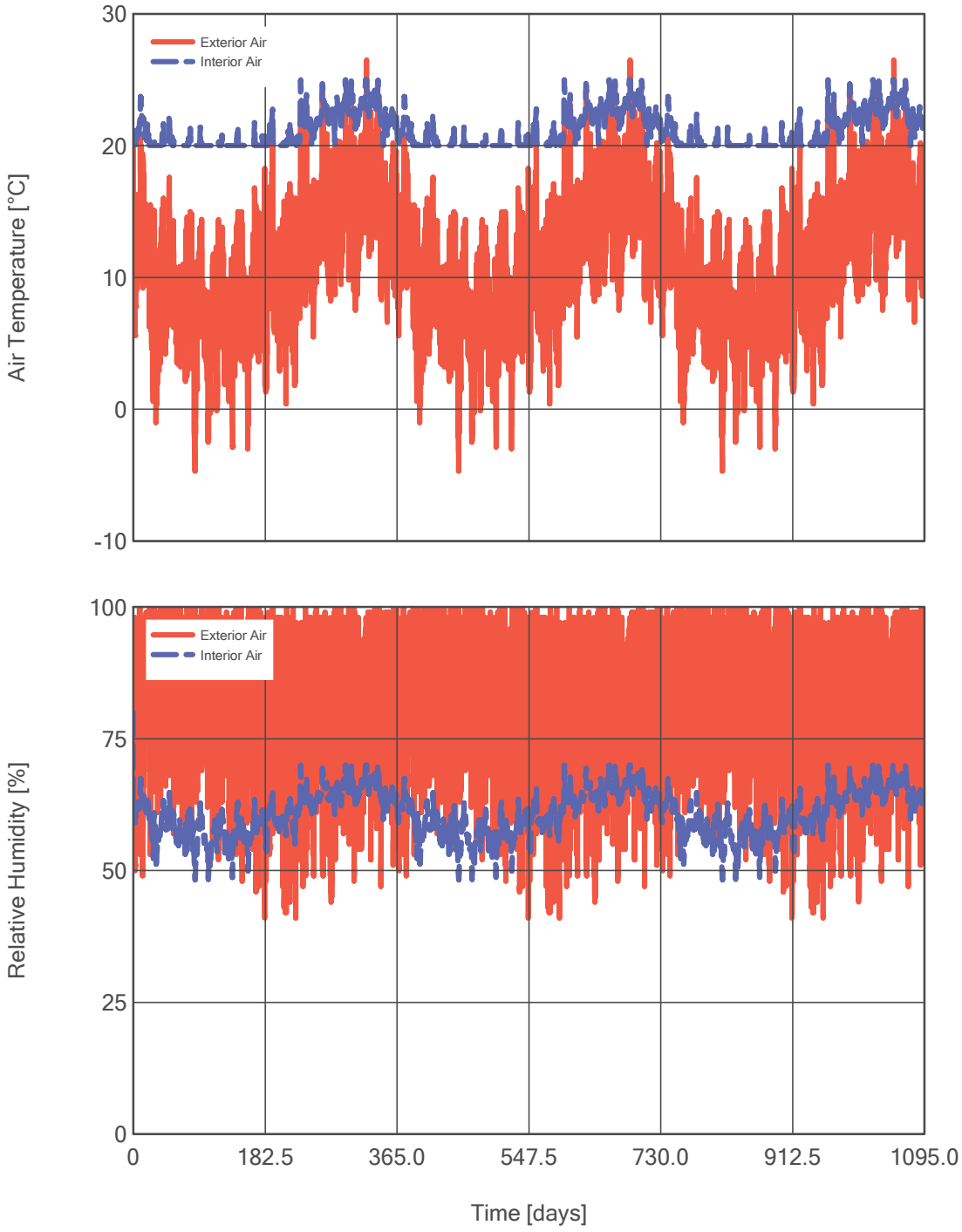
Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	0.212
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Stack5m ACH 10 (Moisture Source)	[kg/m²]	0.212

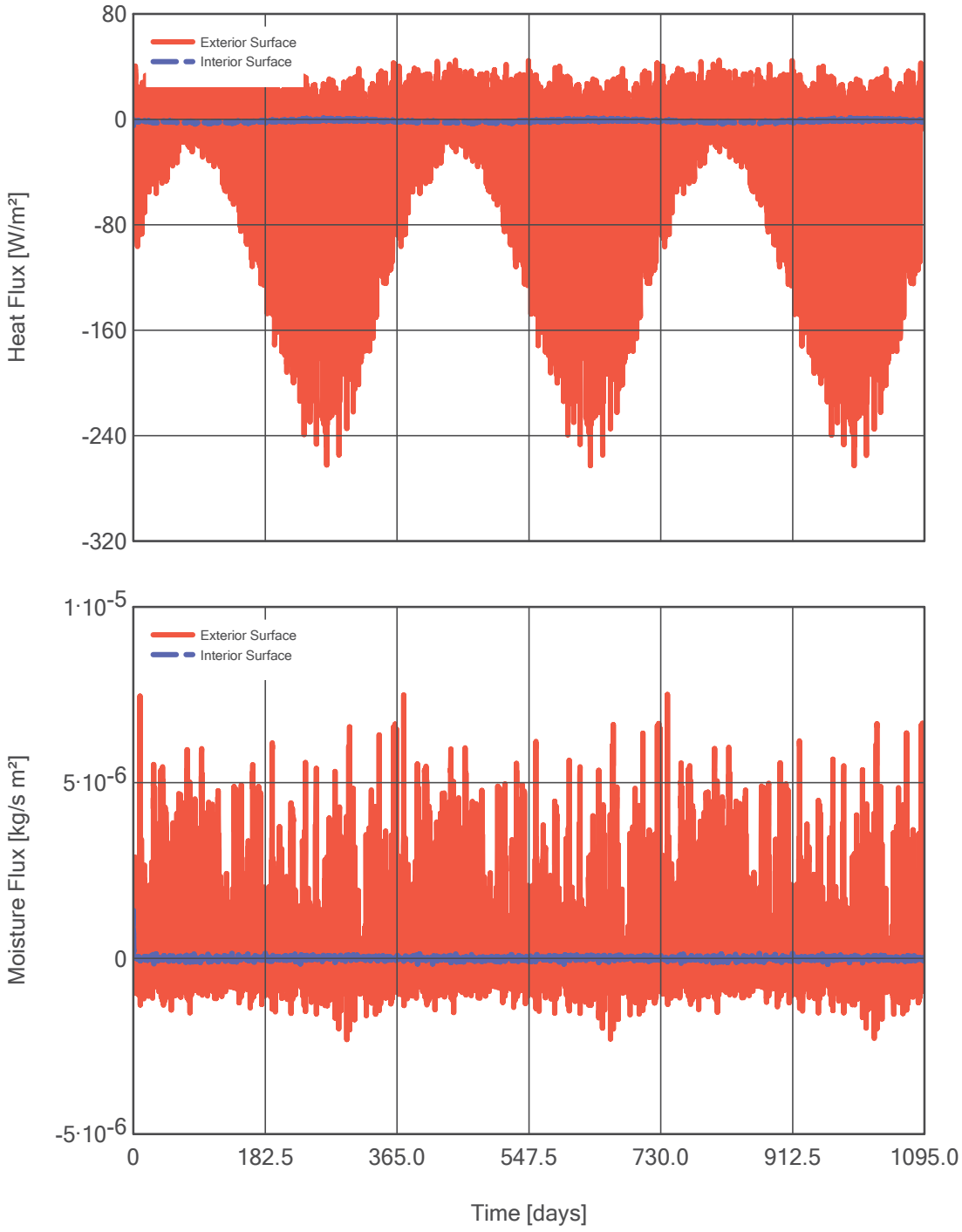
Rain, Radiation (Exterior Climate)



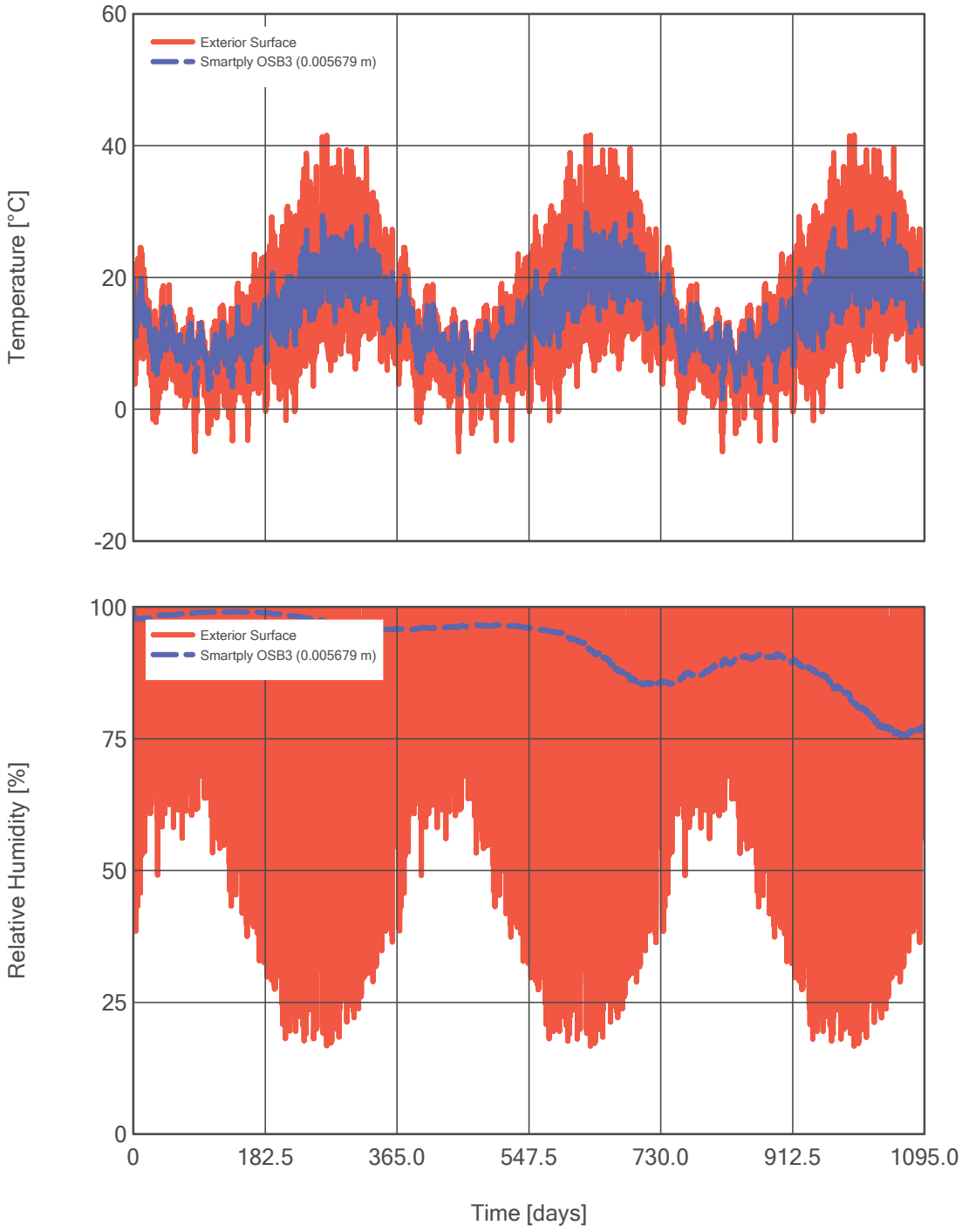
Air Temperature, RH (Exterior, Interior)



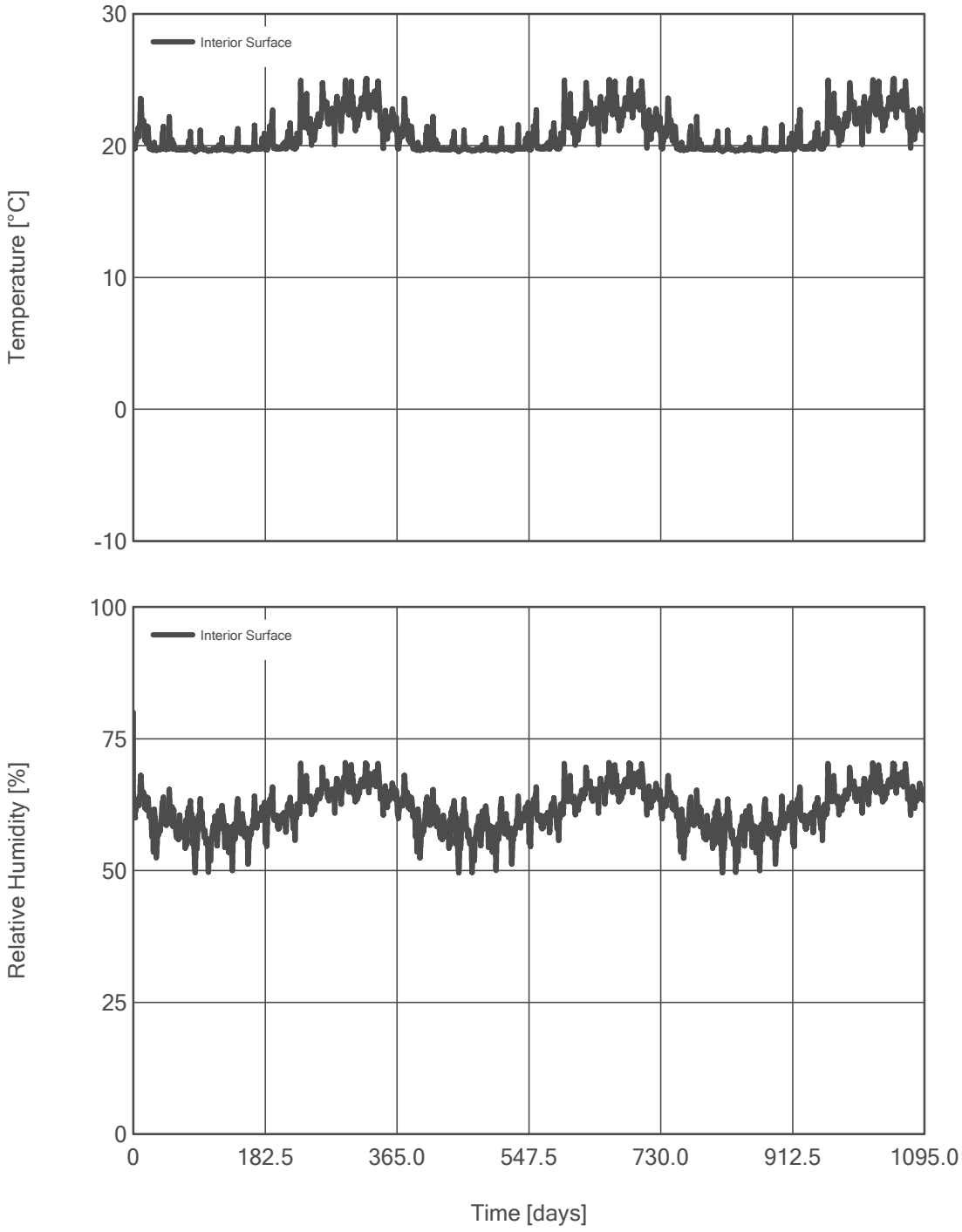
Heat, Moisture Fluxes



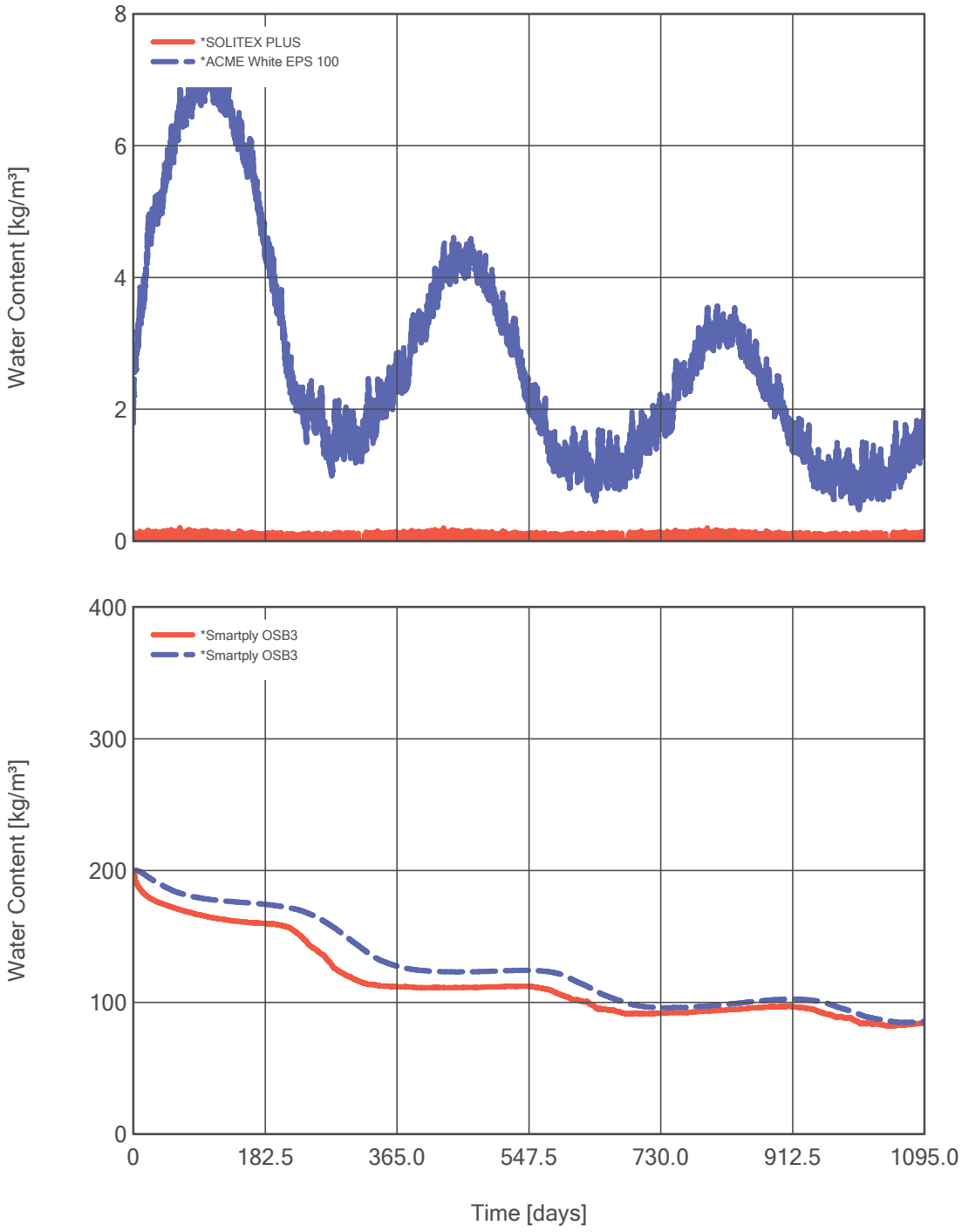
Temperature, RH (Monitor Position 1, 2)



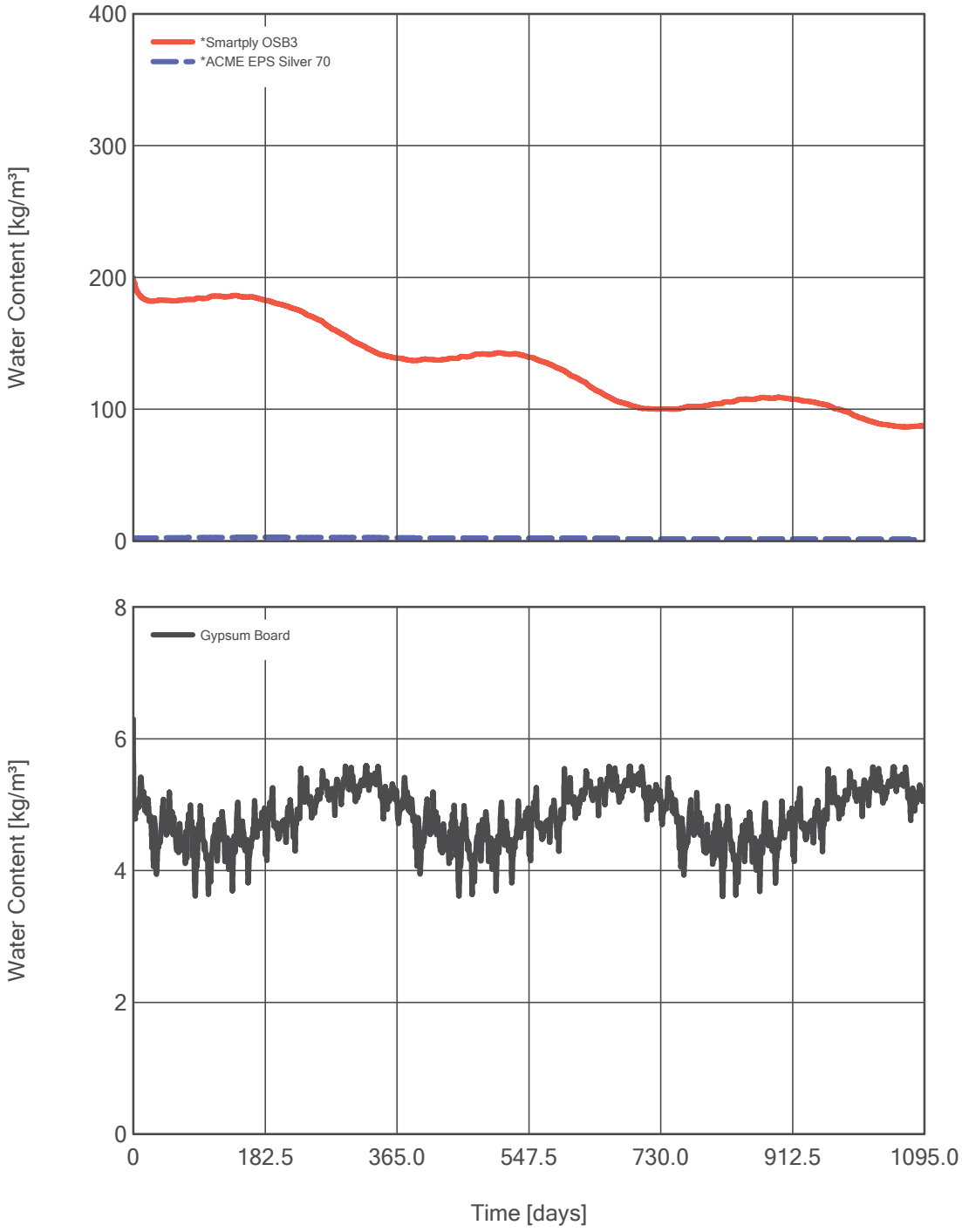
Temperature, RH (Monitor Position 3)



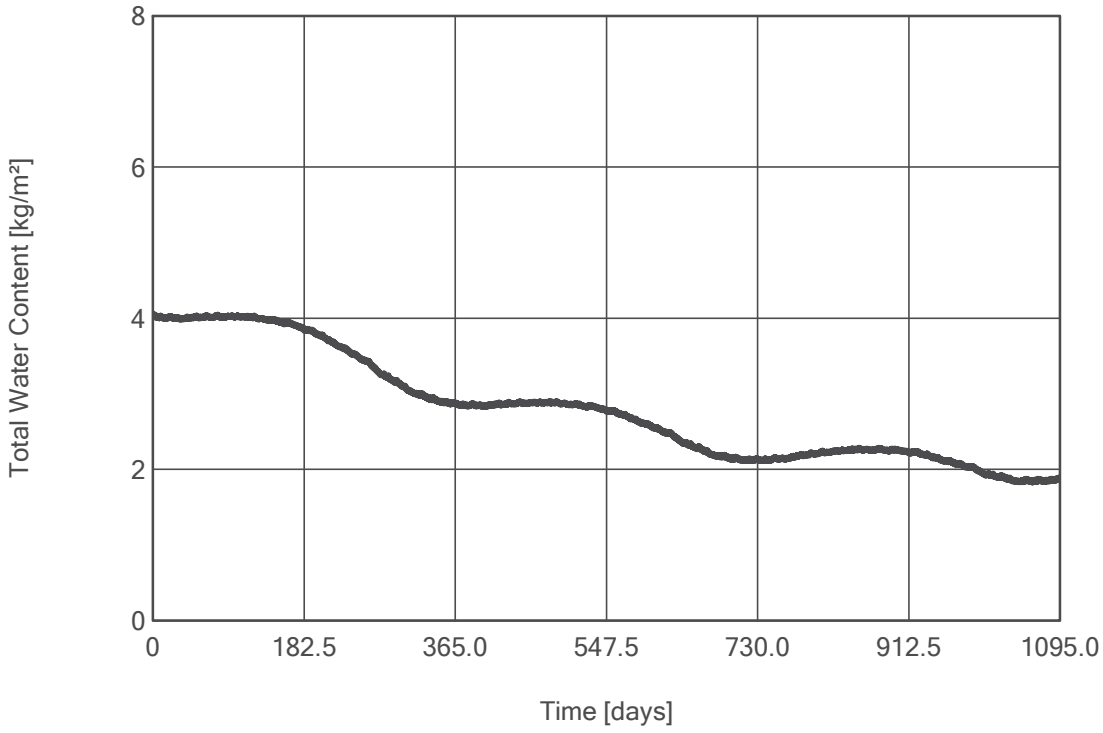
Water Content of Individual Materials



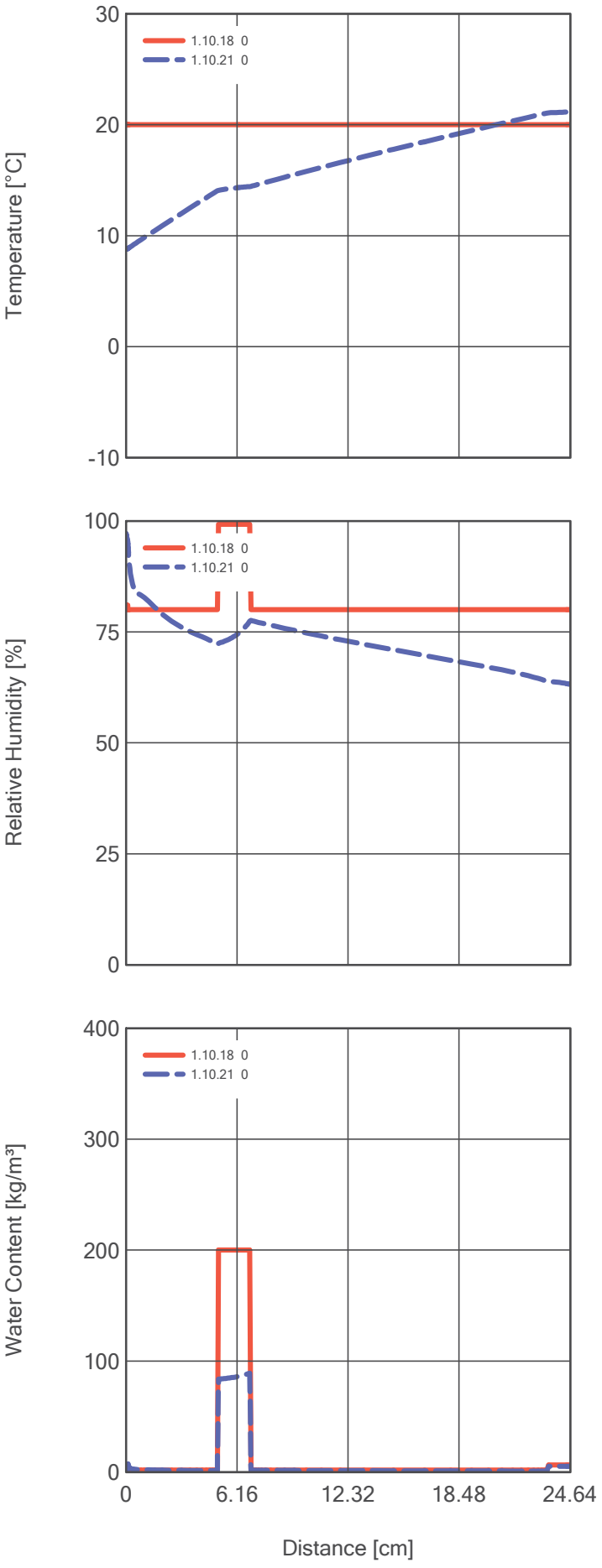
Water Content of Individual Materials



Total Water Content in Construction



Profiles


30
20
10
0
-10
Temperature [°C]
1.10.18 0
1.10.21 0
100
75
50
25
0
Relative Humidity [%]
1.10.18 0
1.10.21 0
400
300
200
100
0
Water Content [kg/m³]
1.10.18 0
1.10.21 0
0
6.16
12.32
18.48
24.64
Distance [cm]