Prime Consulting Engineers Pty. Ltd.

Condensation Risk Assessment

For

Project: X-PLUS Ritek Wall System – Climate Zones 2, 3, 5 & 6

Ref: R-24-810-1

Date: 23/04/2024

Revision: B

Document Control

Should you have any queries relating to any technical aspects of this report please contact our office on (02) 8964 1818. The recipient of the latest issue as noted above will be responsible for superseding/destroying all previous documents.

Document Authorisation

RECIPIENT(S):	Mark Hillyer Jamie Somerville-Kimlin
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Rev.	Date	Issue for	Prepared by	Checked by
0	23/04/2024	Client's Review	KZ	BG

Summary of Amendments

Rev.	Section(s)	Description
0	-	-
A	11. Summary	Additional clarifications provided
B	Various	Wall type

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1 Introduction

Prime Consulting Engineers was engaged by Ritek Technology PTY LTD to conduct a condensation and mould growth risk analysis using WUFI PRO software to provide consultancy advice pertaining to the condensation management compliance of 150mm – 200mm X-PLUS Ritek wall system, in accordance with the Verification Method F8V1 of the NCC 2022 for Climate Zones 2,3, 5 &6.

It should be noted that the outcome of our analysis is limited to the selected items as outlined in this report. This report shall be read in conjunction with the documents listed in the references (Cl. 6).

2 Objectives

The aim of this report is:

- To provide a professional judgement/assessment/opinion, in accordance with the relevant Assessment Methods as stipulated in the NCC 2022
- Evaluate the outcomes of the condensation and mould growth risk assessment for a 10-year WUFI simulations model to provide a professional judgement for 150mm – 200mm X-PLUS Ritek Wall System for Climate Zones 2, 3, 5 & 6.

3 Executive Summary

Our analysis conclusively demonstrates that 150mm – 200mm Ritek X-PLUS series walls, when enhanced with an external weatherproof render compliant to AS 4284 and relevant NCC requirement, successfully mitigate the risks of condensation. The post-construction walls maintain a mould growth factor below 3, which is well within the limits prescribed by NCC 2022, thereby ensuring a healthy environment as mandated by clause F3P1. These results validate that the wall system meets the F8V1 requirements for effective condensation management within the building envelope.

The application of a weatherproof render significantly contributes to the walls' performance by preventing external moisture penetration and facilitating proper moisture management within the wall assembly. This compliance report not only underscores the walls' capability in maintaining structural integrity and occupant health but also highlights their adaptability to various Australian climate conditions.

4 Definition

- **Condensation:** Condensation refers to the formation of moisture on the surface of a building element or material as a result of moist air coming into contact with a surface which is at a lower temperature.
- **Mould:** A fungal growth that can be produced from conditions such as dampness, darkness, or poor ventilation.

- **Pliable building membrane:** A water barrier as classified by AS 4200.1.
- **External wall:**
  - NCC Volume One: an outer wall of a building which is not a common wall.
  - NCC Volume Two: an outer wall of a building which is not a separating wall.
- **Climate zone:** An area defined in Figure 2 and Table 3 of the NCC 2022 for specific locations.

5 Assumptions and Limitation

- The works are limited to the scope described above. The analysis evaluates annual moisture profiles to determine the condensation and mould growth risk under 'worst case' external and internal moisture conditions.
- The opinion is based on relevant details from Ritek Technology PTY LTD's.
- The external finishing of the wall is assumed to be a weatherproof render compliant to AS 4284.
- The assessment is limited to 150mm – 200mm Ritek X-PLUS Wall System
- Climate data prepared by NatHERS have been used throughout this report.
- The Internal temperature and Relative humidity calculated as per ASHRAE 160 standard is based on Airconditioned 2-bedroom residential apartment with 21.1 ^{o}C minimum internal temperature. Refer to Cl. 9.1 for the analysis model and details. Any deviation from this standard volume and moisture generation will alter the results. Local climate specifics may also cause minor variations.
- Condensation and mould growth risk assessment is limited to Climate Zones 2,3,5 & 6. Refer to Cl. 7.2 for climate zones in Australia. Climate data from the following cities were used in our analysis as representatives of four distinct climate zones in Australia:
  - **Climate Zone 2:** Brisbane, QLD
  - **Climate Zone 3:** Charleville, QLD
  - **Climate Zone 5:** Sydney, NSW
  - **Climate Zone 6:** Melbourn, VIC
- Simulation (cycling) is limited to 10 years for the assessment of the condensation and mould growth risks as per AIRAH DA07 guideline.
- Windows, doors and other systems are excluded from this report.
- Factors such as Rain, Wind, Heat Transfer, Radiation, etc. are considered in this report based on climate data prepared by NatHERS.
- Construction period is assumed to be a minimum of 9 months.
- Assumptions for the materials used in this study are presented in Appendix 'A'. Any variation from the materials stated may result in a deviation from the results presented herein. Only like for like replacements are acceptable.

- Corrosion: This report does not assess the corrosion of metals used in construction. Requirements for prevention of corrosion shall be derived from the properties and function of the particular metals used in construction.
- PCE has assumed that all design and installation works will be carried out in strict accordance with the recommendations from Ritek Technology PTY LTD.
- This report has been prepared for Ritek Technology PTY LTD and should not be relied upon by any third party.
- No responsibility is undertaken to any third party in the use of this report.

6 References

- The documents referred to in this report are as follows:
  - Ritek X-PLUS Wall System Technical Data
  - National Construction Code (NCC) 2022, Vol. 1 & 2
  - The program(s) used for the wind analysis is WUFI PRO V6.7
- Standards and guidelines used:
  - ASHRAE 160
  - AIRAH DA07
  - The Blue Book V1.0 prepared by Pro Clima

7 Background

7.1 Ritek X-PLUS Wall System

Ritek Wall Systems are prefabricated permanent formwork systems for concrete walls used for all types of external and internal walls. The Ritek X-PLUS Wall System panels consist of 6mm fibre-cement, recessed-edge facing sheets, bonded to vertical studs. Refer to the table below for X-PLUS Wall panel thicknesses.

Ritek® X-PLUS Wall System Specification			
X-PLUS Wall Panel Thickness	**Concrete Core**	**Surface Density**	**Typical Panel Weight**
150mm	138mm	> 220 kg/m^2	23 kg/m^2
165mm	153mm	> 220 kg/m^2	24 kg/m^2
200mm	188mm	> 220 kg/m^2	26 kg/m^2

7.2 Climate Zones

The National Construction Code (NCC) of Australia categorizes different parts of the country into specific climate zones to guide the construction of buildings that are efficient and suitable for their environments. These climate zones are determined based on a variety of factors including temperature, humidity, and rainfall, which influence building design, particularly in terms of heating, cooling, and ventilation systems.

7.2.1 Overview of Climate Zones in the NCC

Australia is divided into eight climate zones for the purposes of the NCC, each with distinct climatic characteristics:

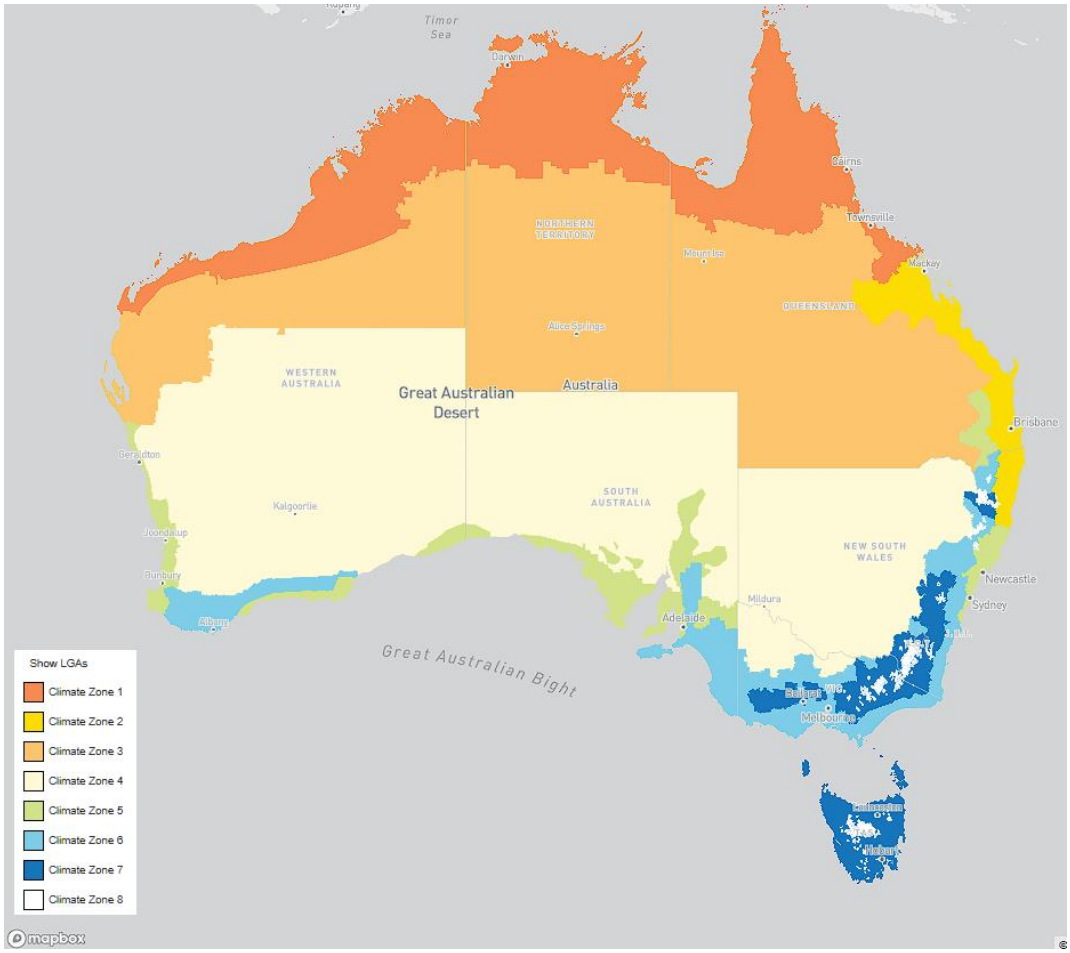


Figure 1 Climate Zone Maps (ABCB)

Zone 1 – Tropical: Northern Australia from Exmouth (Western Australia) across the country to south of Townsville (Queensland).

Zone 2 - Subtropical (with summer rainfall): Coastal Queensland from north of Mackay (Queensland) down to just south of Coffs Harbour (New South Wales).

Zone 3 - Hot dry (with summer rainfall): Northern central Australia from Carnarvon on the Western Australian coast across the deserts to Alice Springs and north of Tennant Creek (Northern Territory), to Mount Isa (Queensland) and down the Queensland hinterland to the New South Wales border, but not the coast, and to Charleville (Queensland).

Zone 4 - Hot dry (with winter rainfall): Most of southern central Australia from the Western Australian coastal hinterland across most of inland South Australia, inland New South Wales and inland Victoria, encompassing Yalgoo, Warburton, Coober Pedy, Whyalla, Broken Hill, Mildura, Bourke, Tamworth, and Albury-Wodonga.

Zone 5 - Warm temperate: Several regions across the country: – the coastal strip of Western Australia from 27 to 34 degrees south encompassing Geraldton, Perth and Bunbury – a coastal strip encompassing Esperance (Western Australia) – a coastal strip encompassing Eucla

(Western Australia) – coastal areas of South Australia encompassing Ceduna and Adelaide and some hinterland areas north of Whyalla and east of Adelaide – a coastal strip of New South Wales encompassing Wollongong, Sydney, Newcastle up to 32 degrees south – a hinterland strip west of Brisbane (Queensland).

Zone 6 - Mild temperate: Several regions across the country – coastal and hinterland strip of southern Western Australia encompassing Albany – hinterland north of Adelaide (South Australia), coastal and hinterland area from Kangaroo Island and Adelaide around coastal and hinterland Victoria encompassing Ballarat and Melbourne – the coastal strip of southern and hinterland New South Wales west of Sydney as far north as 28 degrees south.

Zone 7 - Cool temperate: Sub-alpine areas of Victoria and southern New South Wales: – the south-eastern coast of Victoria – a small area around Glen Innes (New South Wales) – most of Tasmania and Bass Strait islands.

Zone 8 – Alpine: Alpine areas of Victoria, New South Wales, and Tasmania.

8 BCA Performance Requirements & Verification Methods

8.1 Condensation Management

Part F8 of the NCC 2022 Volume one sets forth specific requirements to mitigate the risks associated with condensation within buildings. Key aspects of these requirements, particularly referencing clauses such as F8P1 and F3P1, are detailed below to ensure compliance in building designs.

8.1.1 Performance Requirements

8.1.1.1 F8P1 - Condensation and water vapour management

Risks associated with water vapour and condensation must be managed to minimise their impact on the health of occupants. It should be noted that F8P1 only applies to a sole-occupancy unit of a Class 2 building or Class 4 part of a building.

8.1.2 Verification Method

8.1.2.1 F8V1 - Condensation management

(1) Compliance with Performance Requirement F8P1 is verified for a roof or external wall assembly when it is determined that a mould index of greater than 3, as defined by Section 6 of AIRAH DA07, does not occur on—

(a) the interior surface of the water control layer; or

(b) the surfaces of building fabric components interior to the water control layer.

(2) The calculation method for (1) must use—

(a) input assumptions in accordance with AIRAH DA07; and

(b) the intermediate method for calculating indoor design humidity in Section 4.3.2 of AIRAH DA07.

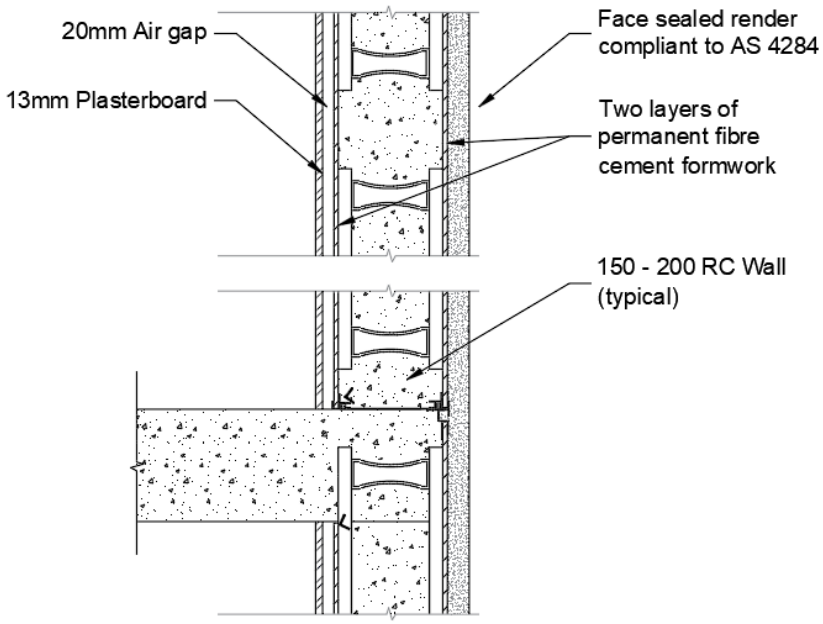
9 Analysis

9.1 Model

9.1.1 Assembly / Wall details

Two different wall types were designed for four climate zones as described below. Refer to Appendix A for more details.

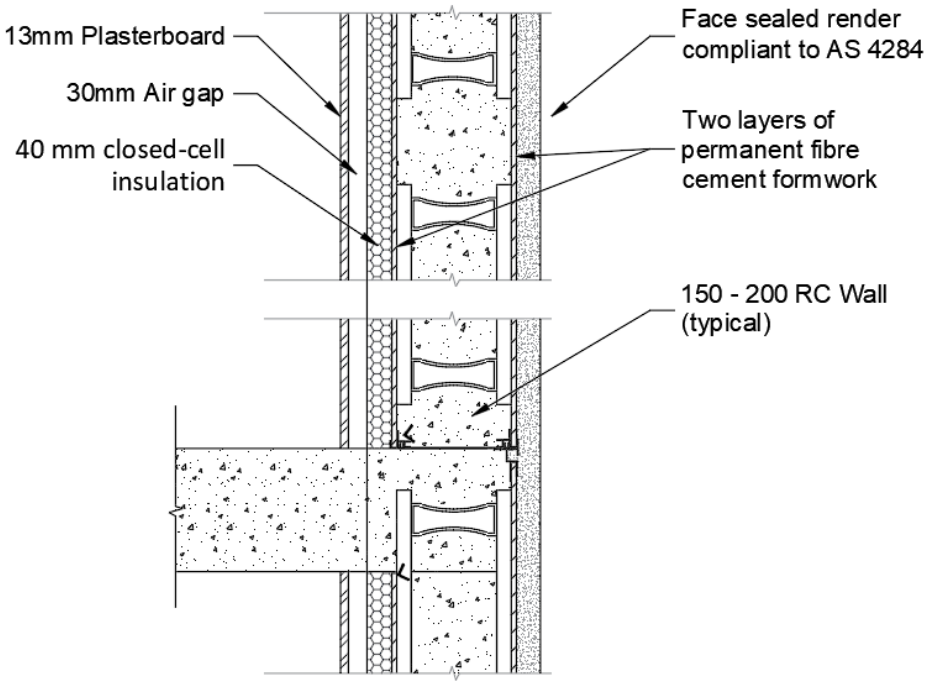
9.1.1.1 Wall type 1:



Wall Type 1

This wall type is suitable for **Climate Zones 2 and 3**. It includes an external weatherproof render compliant with AS 4284 - Testing of building facades, a 150mm to 200mm reinforced concrete Ritek Wall with two layers of 6mm prefabricated permanent formwork fibre cement, a 20mm air gap (furring channel), and a 12.5mm plasterboard finish for the interior. This configuration constitutes a vapour-closed wall system without a dedicated air control layer.

9.1.1.2 Wall type 2:



Wall Type 2

This wall type is suitable for **Climate Zones 5 and 6**. It includes an external weatherproof render compliant with AS 4284 - Testing of building facades, a 150mm to 200mm reinforced concrete Ritek Wall with two layers of 6mm prefabricated permanent formwork fibre cement, a 40 mm directly fixed closed-cell insulation layer against Ritek Wall (without cavity), 30mm air gap (furring channel), and a 12.5mm plasterboard finish for the interior. This configuration also constitutes a vapour-closed wall system without a dedicated air control layer.

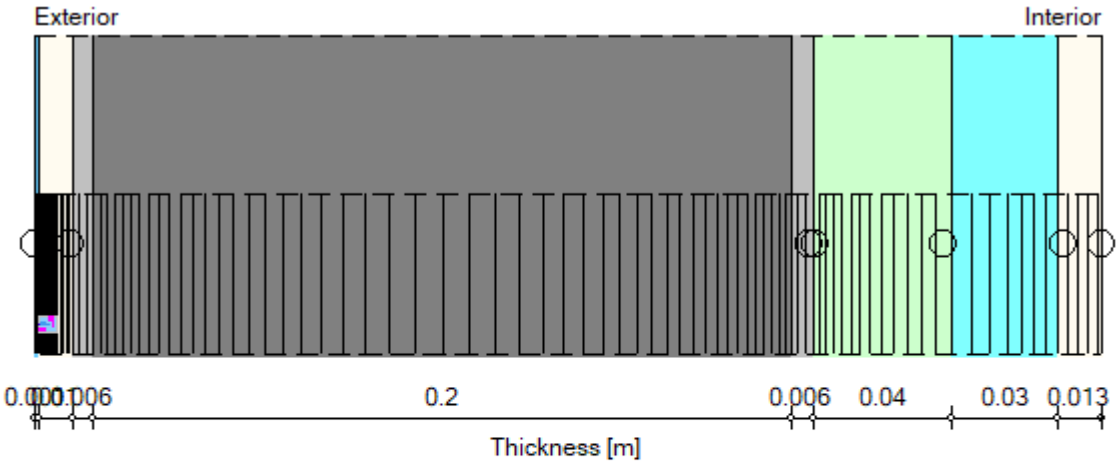
9.1.1.3 Type 1 (Climate Zones 2 & 3)

Materials:

- Wallpaper, acrylic	0.001 m
- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
- Fiber Cement Sheathing Board	0.006 m
- Concrete, C35/45	0.2 m
- Fiber Cement Sheathing Board	0.006 m
- Air Layer 20 mm	0.02 m
- Gypsum Board	0.013 m

Total Thickness: 0.256 m
R-Value: 0.37 (m² K)/W
U-Value: 1.801 W/(m² K)

9.1.1.4 Type 2 (Climate Zones 5 & 6)



Materials:

- Wallpaper, acrylic	0.001 m
- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
- Fiber Cement Sheathing Board	0.006 m
- Concrete, C35/45	0.2 m
- Fiber Cement Sheathing Board	0.006 m
- *Kingspan K12	0.04 m
- Air Layer 30 mm	0.03 m
- Gypsum Board	0.013 m

Total Thickness: 0.306 m
R-Value: 2.02 (m² K)/W
U-Value: 0.453 W/(m² K)

9.1.2 Design Initial Moisture Content

For new construction projects, a moisture content of twice EMC90 for concrete and twice EMC80 for all other materials, unless there are specific drying procedures or protections against moisture during construction. In such cases, EMC90 for concrete and EMC80 for all other materials are used. For retrofit projects, EMC90 for concrete and EMC80 for all other materials are standard unless actual moisture measurements are available.

9.1.3 Indoor Design Parameters

9.1.3.1 Temperature and humidity

As per AIRAH DA07 and ASHRAE 160, indoor temperature and indoor design humidity were calculated based on external climate data parameters. It is assumed that indoor is airconditioned with 3 occupants (2-bedroom residential apartment).

Table 1 Indoor Design Temperature

24-Hour Running Average of Outdoor Temperature	Indoor Design Temperature, °C	
	Heating Only	Heating and Air conditioning
$T_{o,24h} \leq 18.3°C$	21.1°C	21.1°C
$18.3°C < T_{o,24h} \leq 21.1°C$	$T_{o,24h} + 2.8°C$	$T_{o,24h} + 2.8°C$
$T_{o,24h} > 21.1°C$	$T_{o,24h} + 2.8°C$	23.9°C

Table 2 Residential Design Moisture Generation Rate

Number of bedrooms	Number of Occupants	Moisture generation Rate	
1 Bedroom	2	7 L/day	0.8 x 10-4 kg/s
2 bedrooms	3	9 L/day	1.0 x 10-4 kg/s
3 Bedrooms	4	10 L/day	1.2 x 10-4 kg/s
4 Bedrooms	5	11 L/day	1.3 x 10-4 kg/s
Additional Bedrooms	+1 per bedroom	+1 L/day	+0.1 x 10-4 kg/s

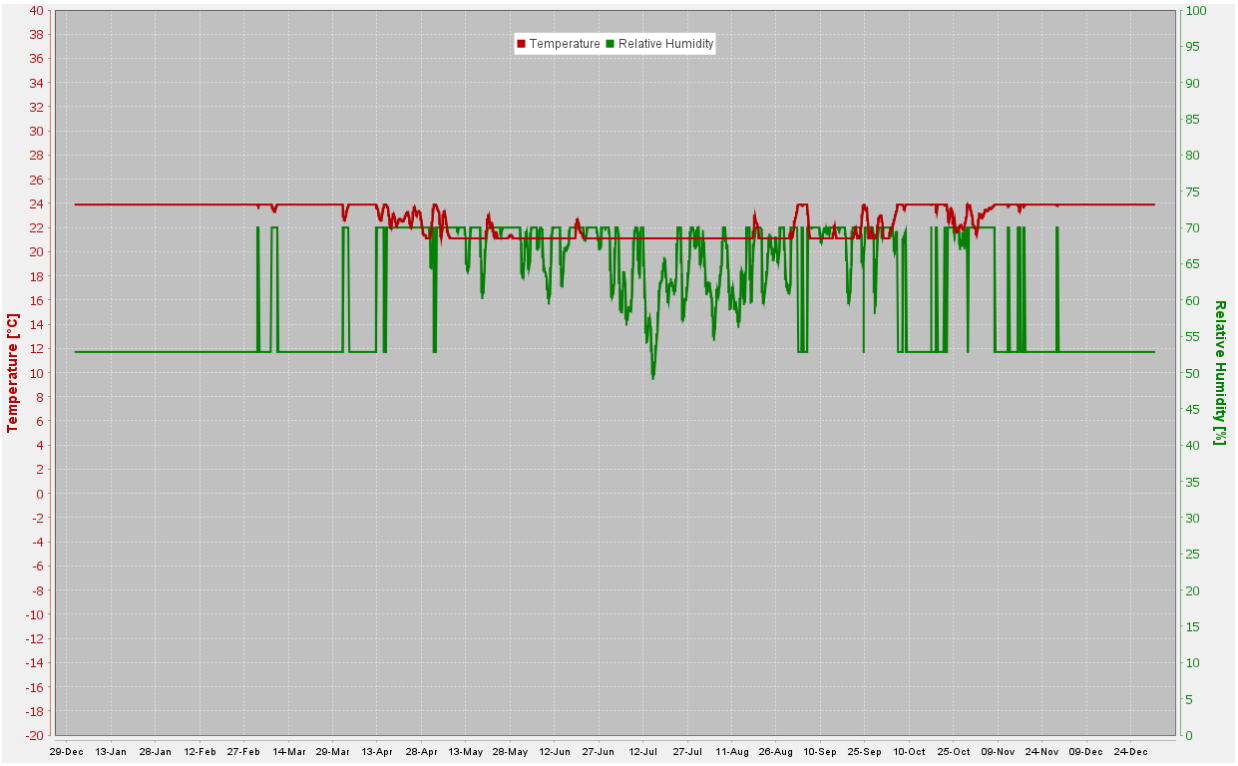


Figure 2 Indoor Temp. & Relative Humidity calculated as per ASHRAE 160 for Brisbane, QLD (Climate Zone 2)

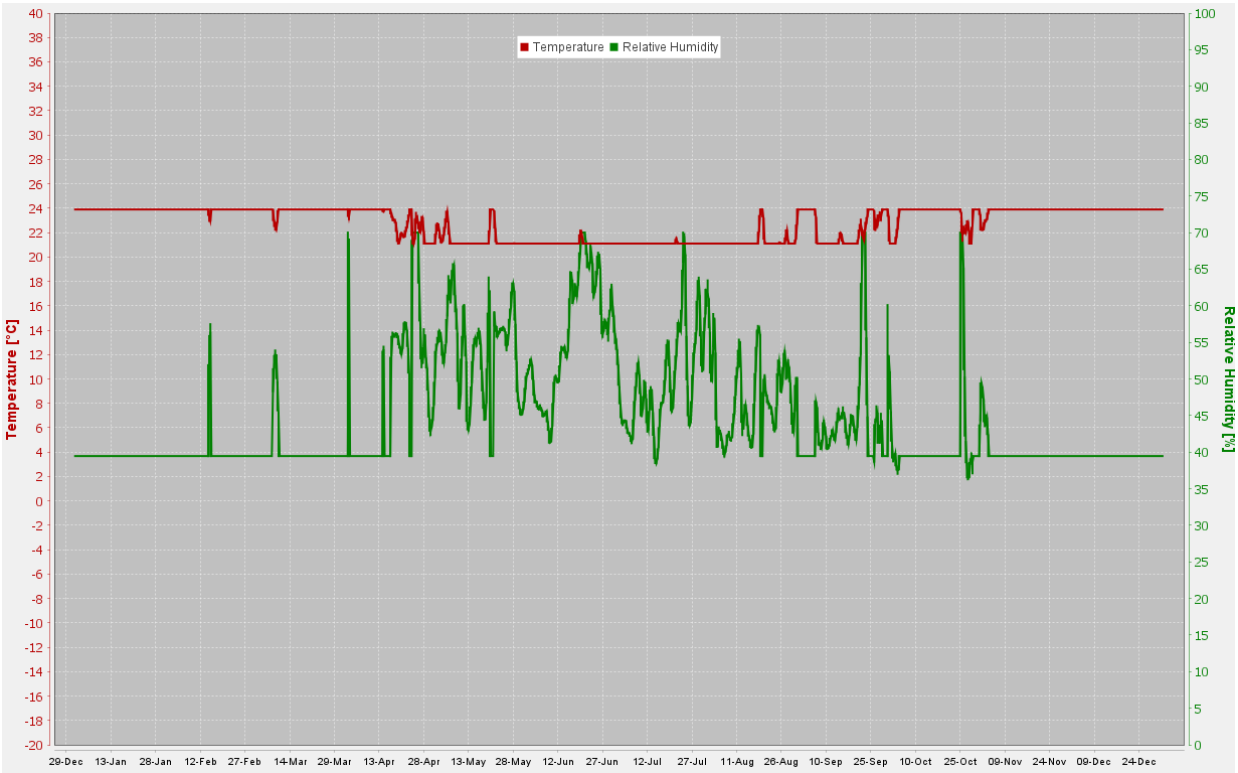


Figure 3 Indoor Temp. & Relative Humidity calculated as per ASHRAE 160 for Charleville, QLD (Climate Zone 3)

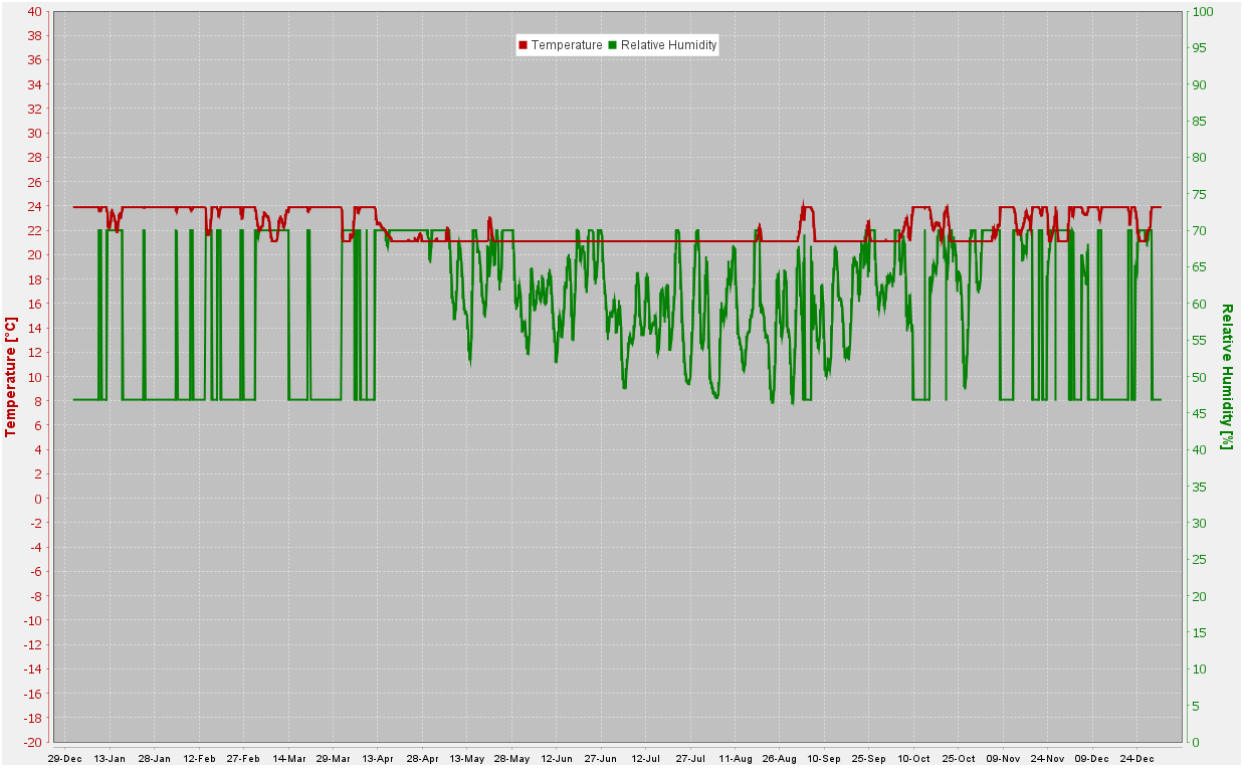


Figure 4 Indoor Temp. & Relative Humidity calculated as per ASHRAE 160 for Sydney, NSW (Climate Zone 5)

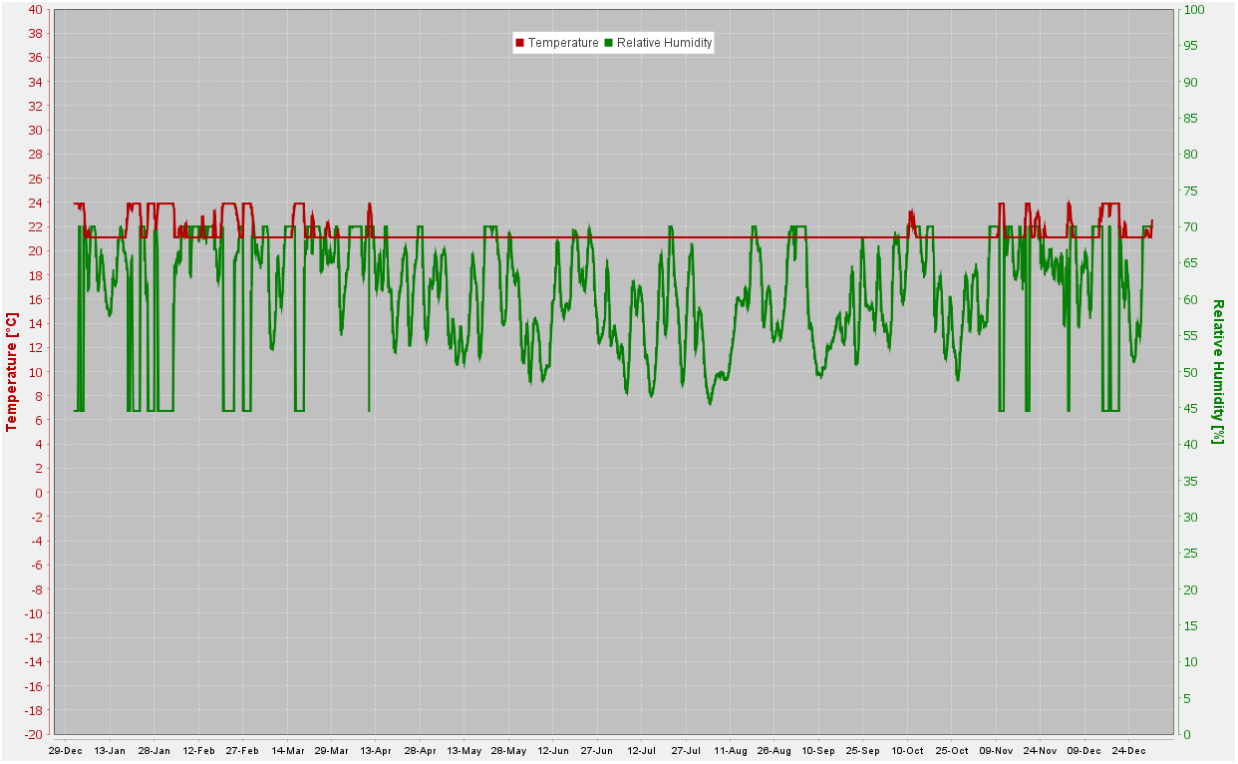


Figure 5 Indoor Temp. & Relative Humidity calculated as per ASHRAE 160 for Melbourn, VIC (Climate Zone 6)

9.1.4 Moisture Source

In addition to rain fall, a leakage scenario was simulated with 1% driving rainwater leak behind the weatherproof layer into the back 5 mm of the render to meet AIRAH DA07 requirements.

9.1.5 Climate Data

9.1.5.1 Climate Zone 2, Brisbane QLD

Location: Brisbane
Latitude [°]: 27.38 South
Longitude [°]: 153.1 East
Altitude [m]: 5
Time Zone: 10.0
Number of data lines: 8760 days (10 Years)

Climate Elements
Temperature: TA
Relative Humidity: HREL
Short-Wave Radiation: ISGH, ISD
Long-Wave Radiation: ILAH
Wind: WS, WD
Rain: RN
Cloud Index: CI

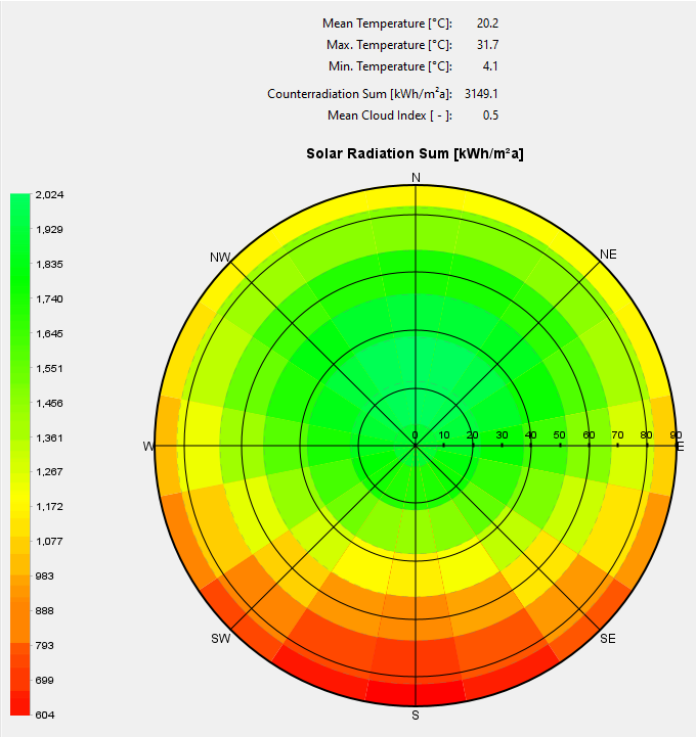


Figure 6 Solar Radiation Graph

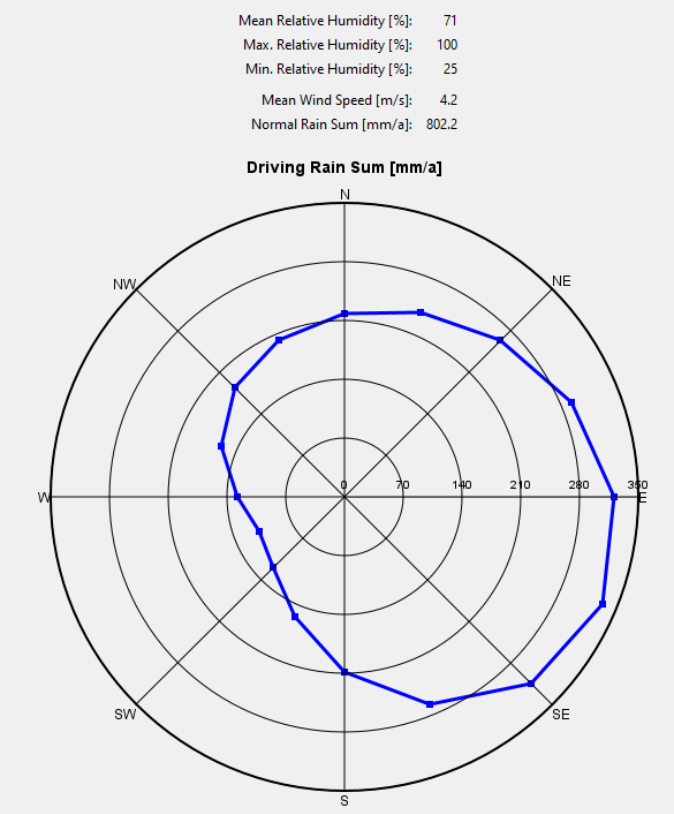


Figure 7 Driving rain and dominant wind direction graph

9.1.5.2 Climate Zone 3, Charleville, QLD

Location: Charleville Airp.
Latitude [°]: 26.4 South
Longitude [°]: 146.27 East
Altitude [m]: 304
Time Zone: 10.0
Number of data lines: 8760 days (10 Years)

Climate Elements
Temperature: TA
Relative Humidity: HREL
Short-Wave Radiation: ISGH, ISD
Long-Wave Radiation: ILAH
Wind: WS, WD
Rain: RN
Cloud Index: CI

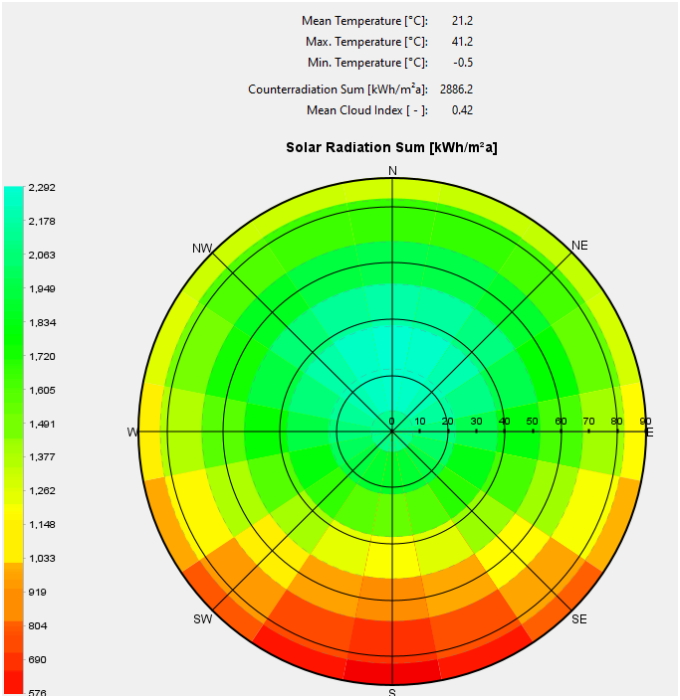


Figure 8 Solar Radiation Graph

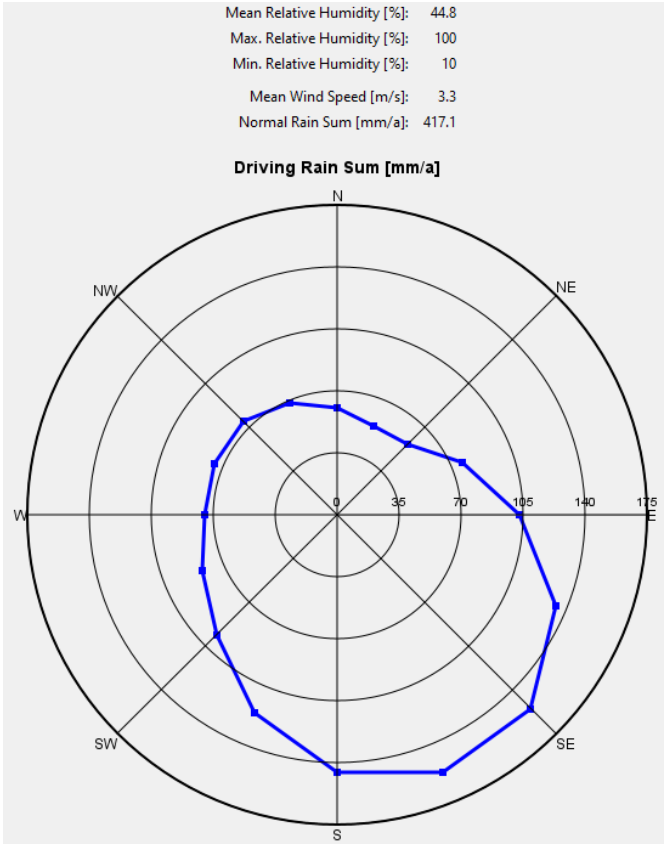


Figure 9 Driving rain and dominant wind direction graph

9.1.5.3 Climate Zone 5, Sydney, NSW

Location: Sydney Intl Airp.

Latitude [°]: 33.95 South
Longitude [°]: 151.18 East
Altitude [m]: 3
Time Zone: 10.0
Number of data lines: 8760 days (10 Years)

Climate Elements
Temperature: TA
Relative Humidity: HREL
Short-Wave Radiation: ISGH, ISD
Long-Wave Radiation: ILAH
Wind: WS, WD
Rain: RN
Cloud Index: CI

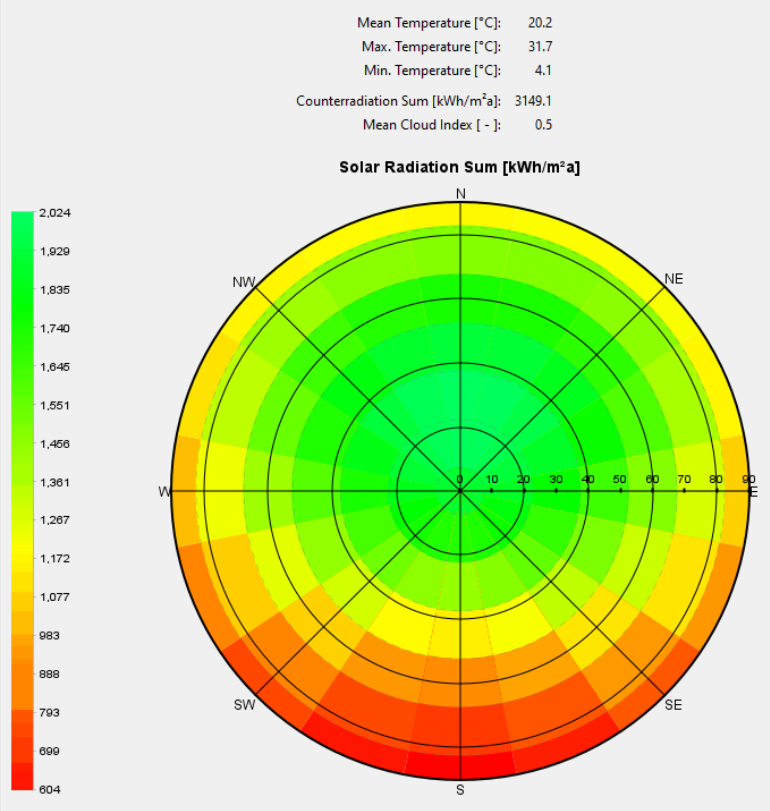


Figure 10 Solar Radiation Graph

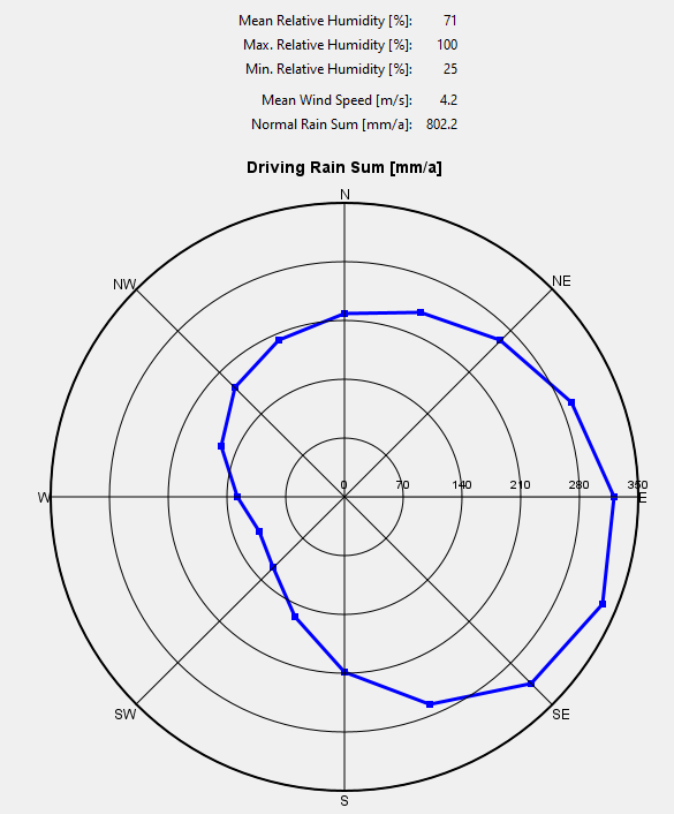


Figure 11 Driving rain and dominant wind direction graph

9.1.6 Climate Data

9.1.6.1 Climate Zone 6, Melbourn, VIC

Location: MELBOURNE/ESSENDON
Latitude [°]: 37.73 South
Longitude [°]: 144.9 East
Altitude [m]: 86
Time Zone: 10.0
Number of data lines: 8760 days (10 Years)

Climate Elements
Temperature: TA
Relative Humidity: HREL
Short-Wave Radiation: ISGH, ISD
Long-Wave Radiation: ILAH
Wind: WS, WD
Rain: RN
Cloud Index: CI

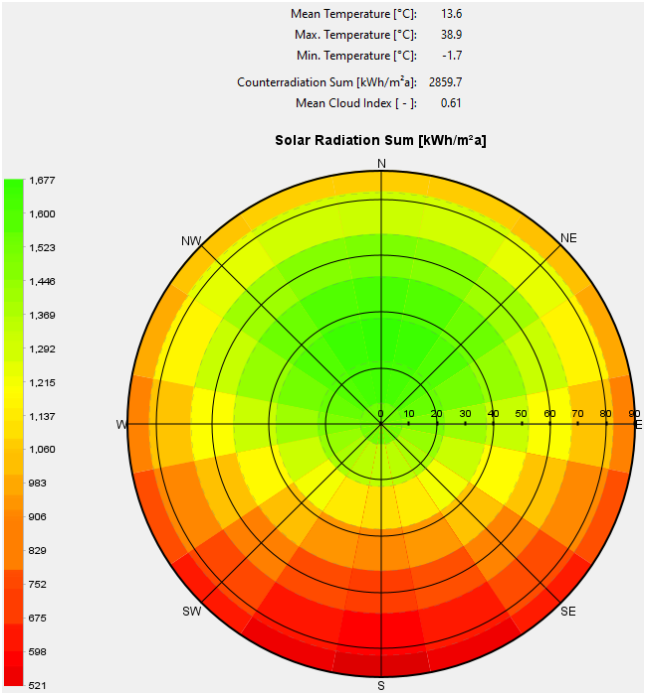


Figure 12 Solar Radiation Graph

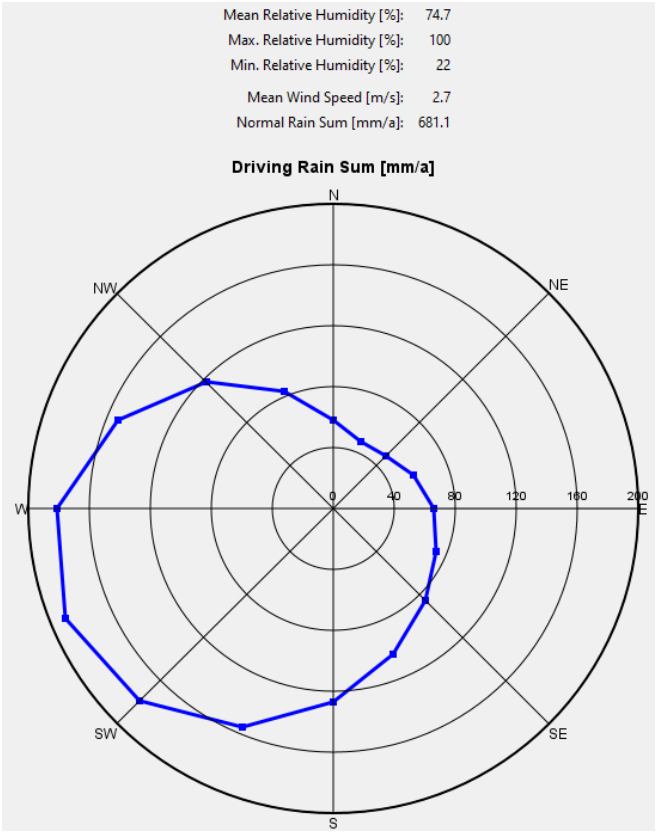


Figure 13 Driving rain and dominant wind direction graph

10 Results

10.1 Climate Zone 2

10.1.1 Total Water Content

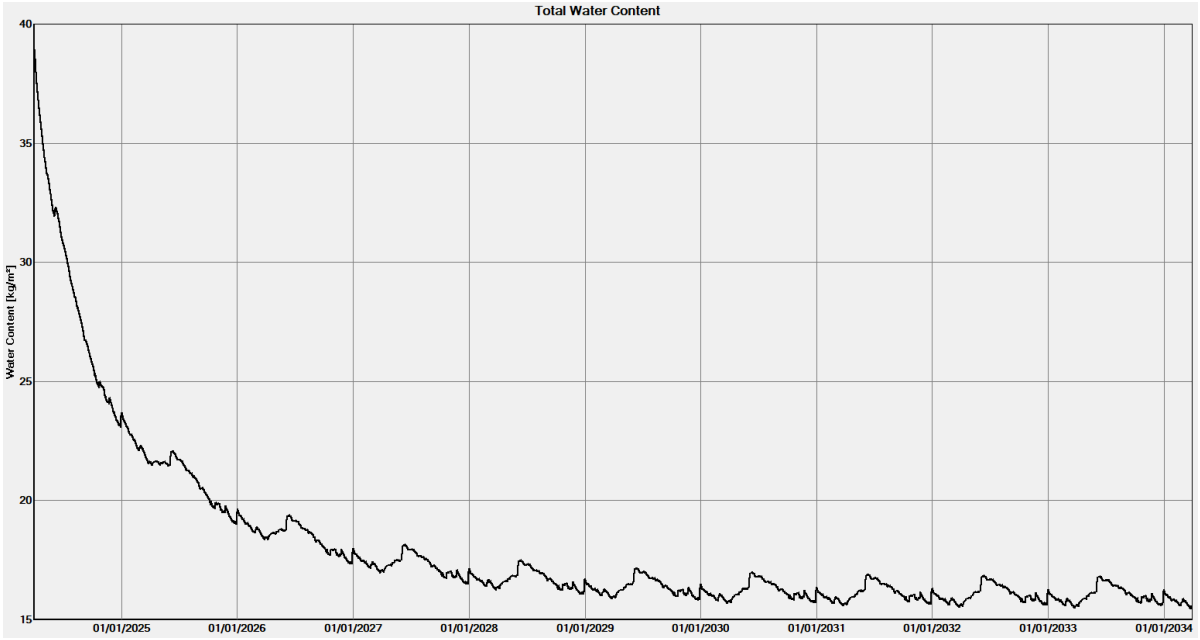


Figure 14 Total Water Content

10.1.2 Water Content at Gypsum (kg/m^3)

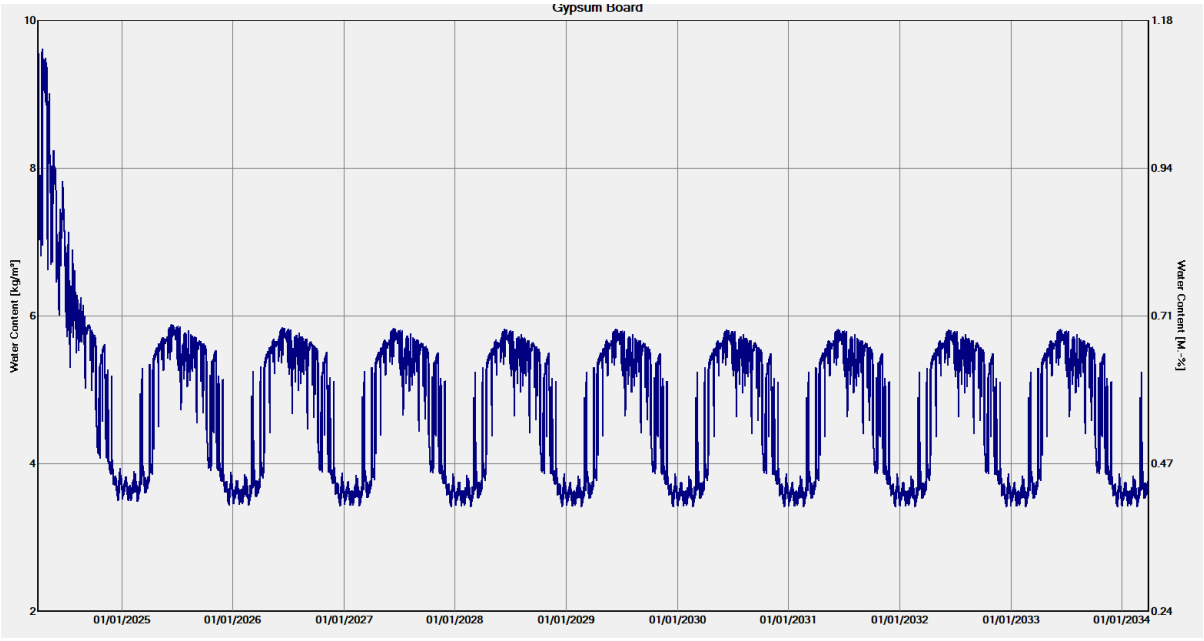


Figure 15 Water Content at Gypsum (kg/m3)

10.1.3 Water Content at Air Gap & Plaster Board (kg/m²)

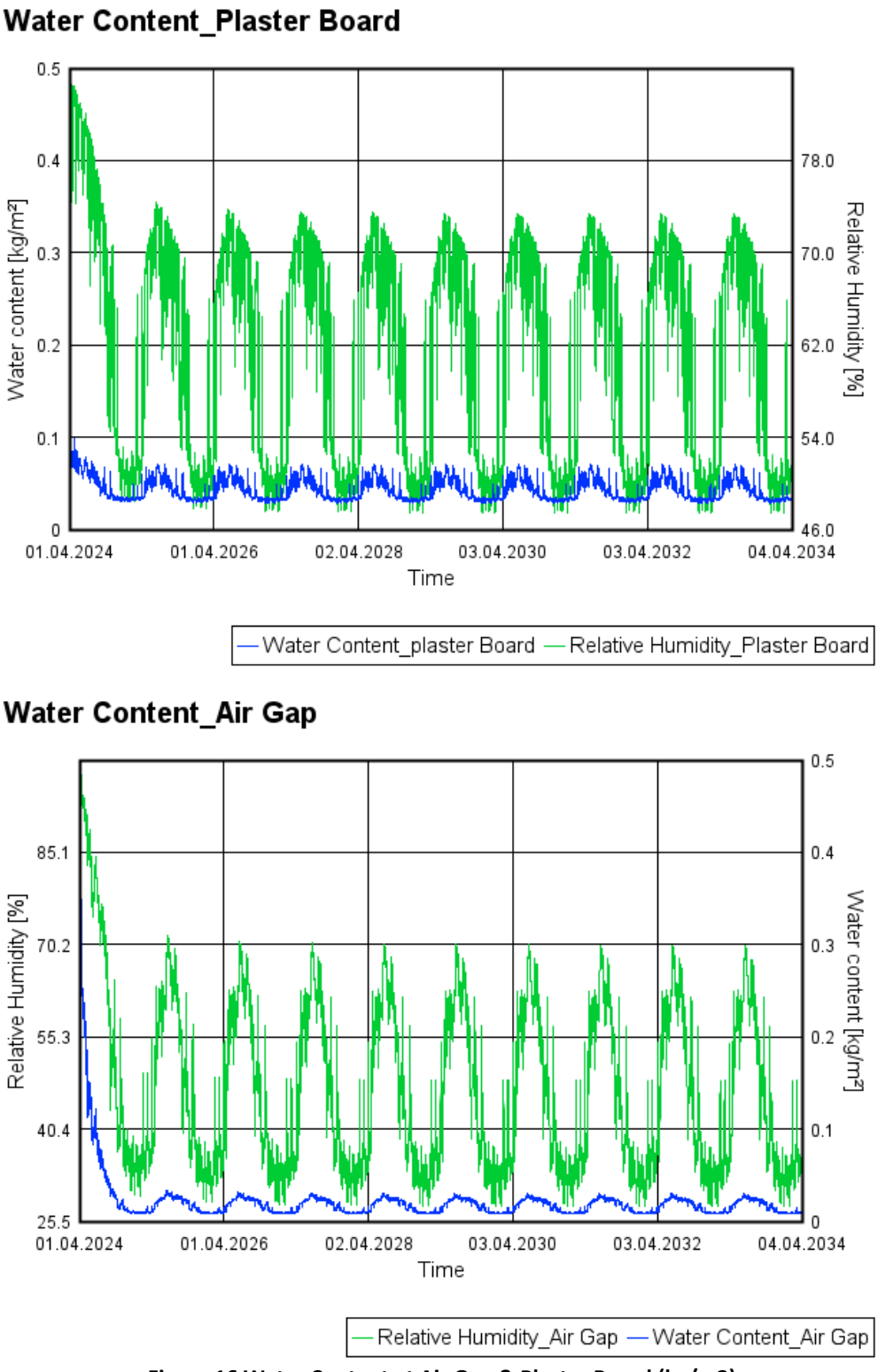
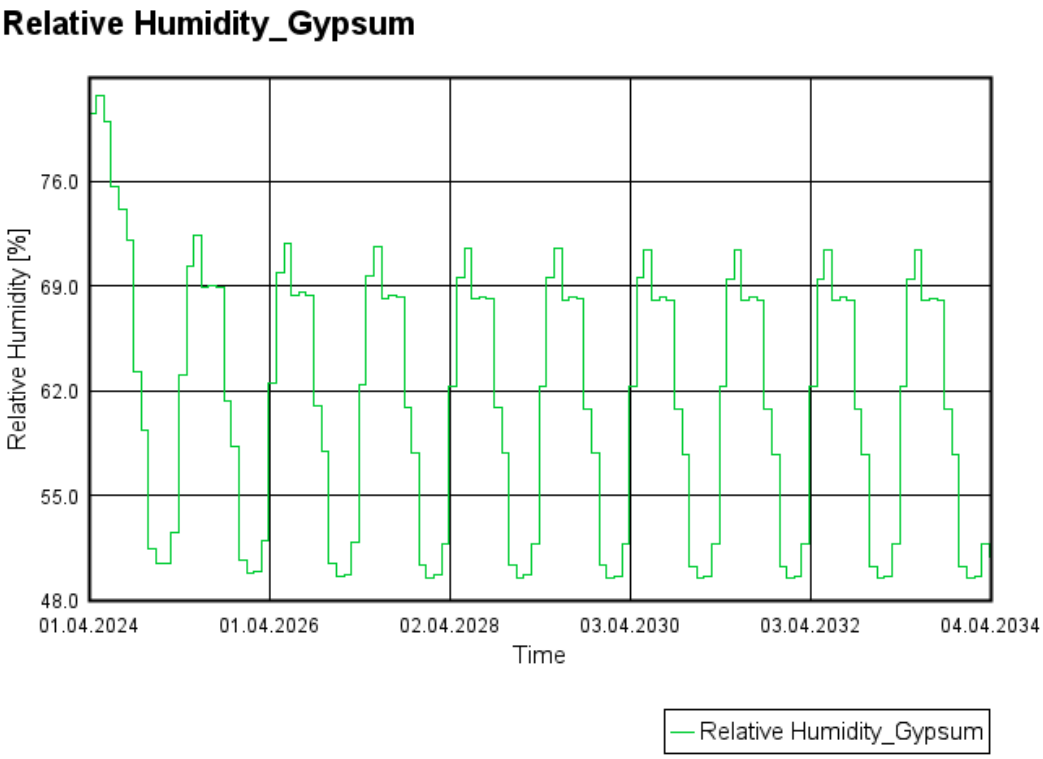


Figure 16 Water Content at Air Gap & Plaster Board (kg/m2)

10.1.4 Relative Humidity at Air Gap & Plaster



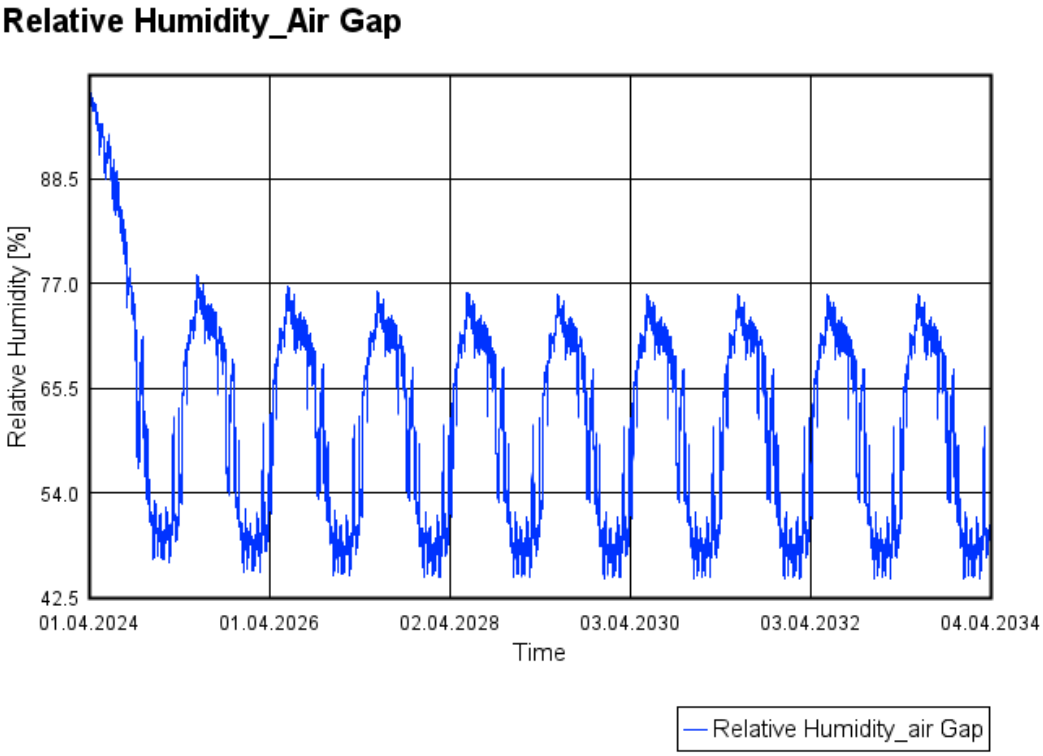


Figure 17 Relative Humidity at Air Gap & Plaster

10.1.5 Internal Temperature Vs. Dew point at the Interior Surface

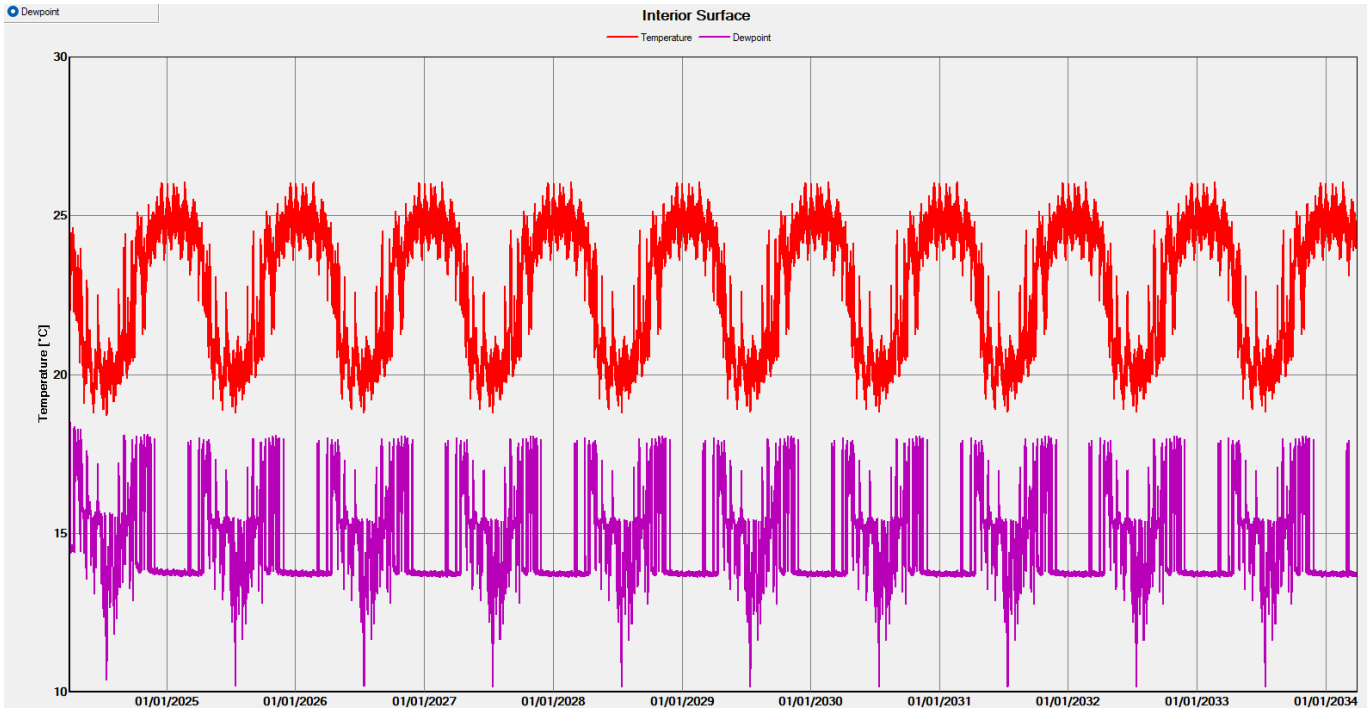


Figure 18 Internal Temperature does not exceed dew point

10.1.6 Summary of Temperature, Water Content and Relative Humidity (Post-Construction)

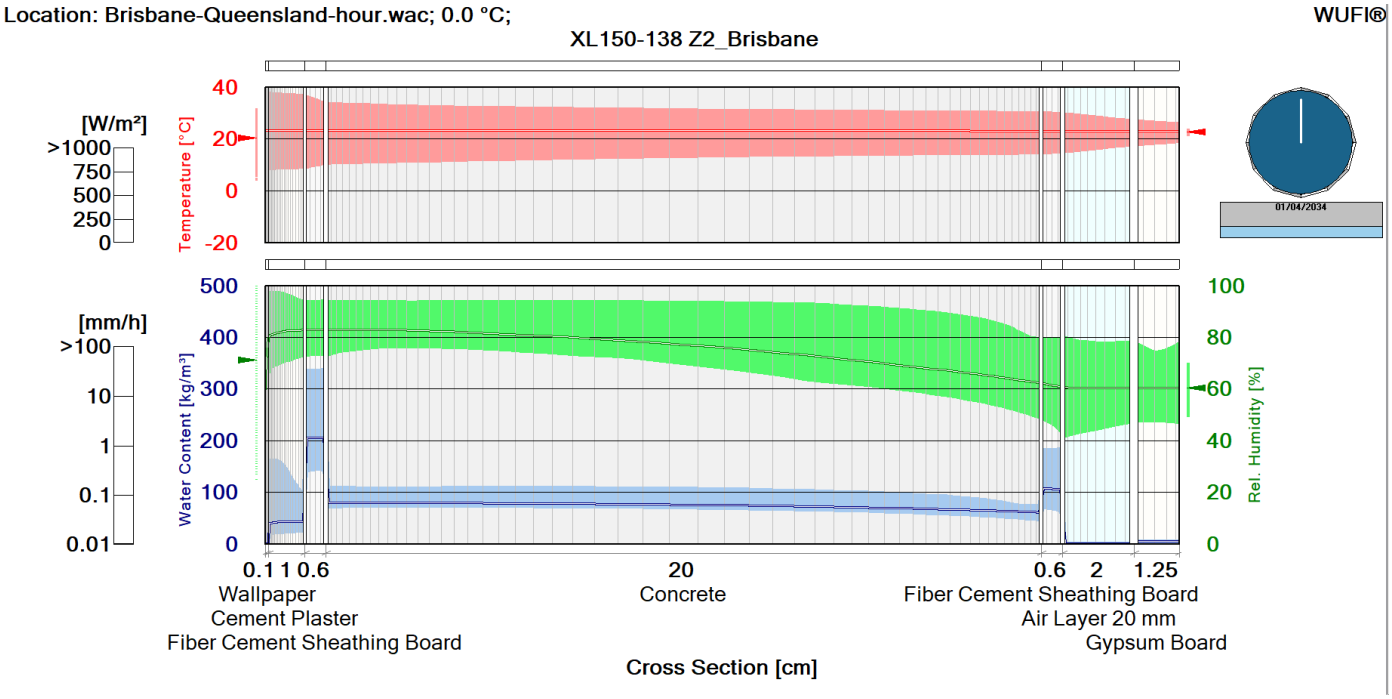


Figure 19 Average of Temperature, Water Content and Relative Humidity (Post-Construction)

10.1.7 Relative humidity (mould growth risk) at the Interior Surface

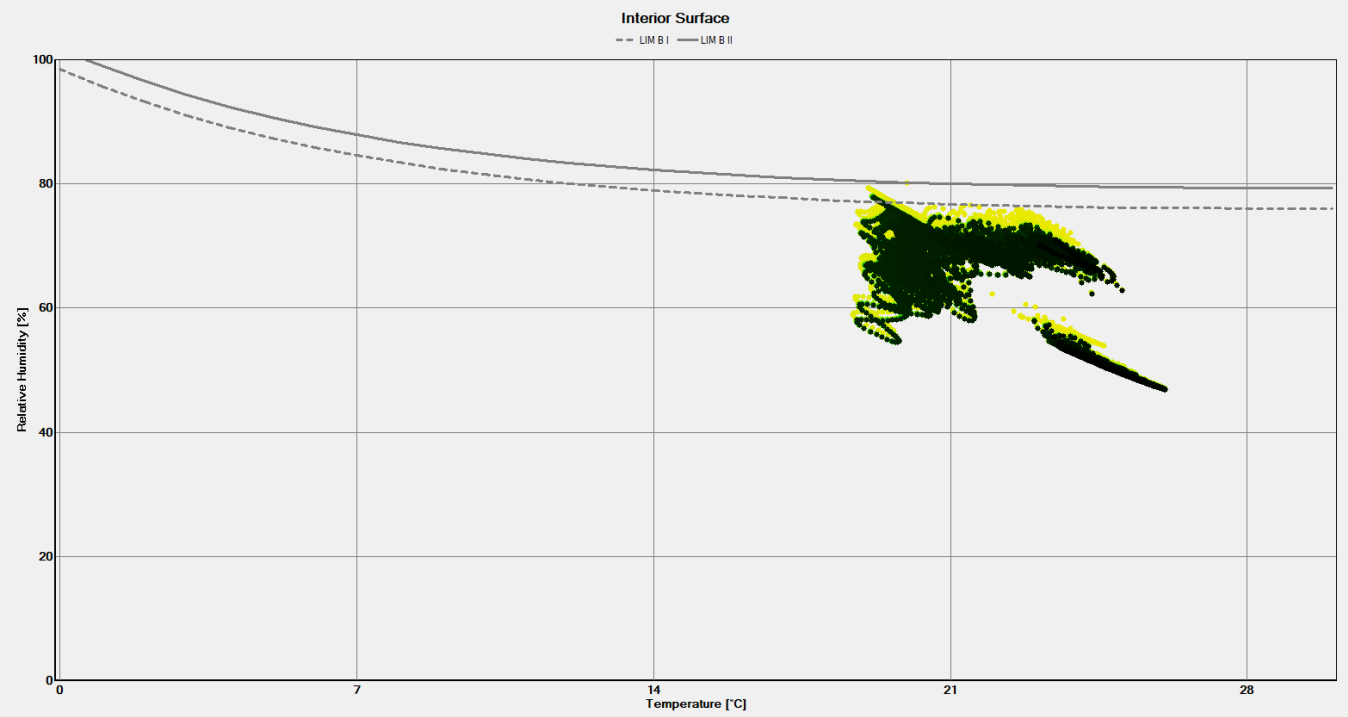


Figure 20 Post Construction <80%. No risk of mould growth at interior face

10.1.8 Mould Growth Risk

10.1.8.1 At Interior Surface

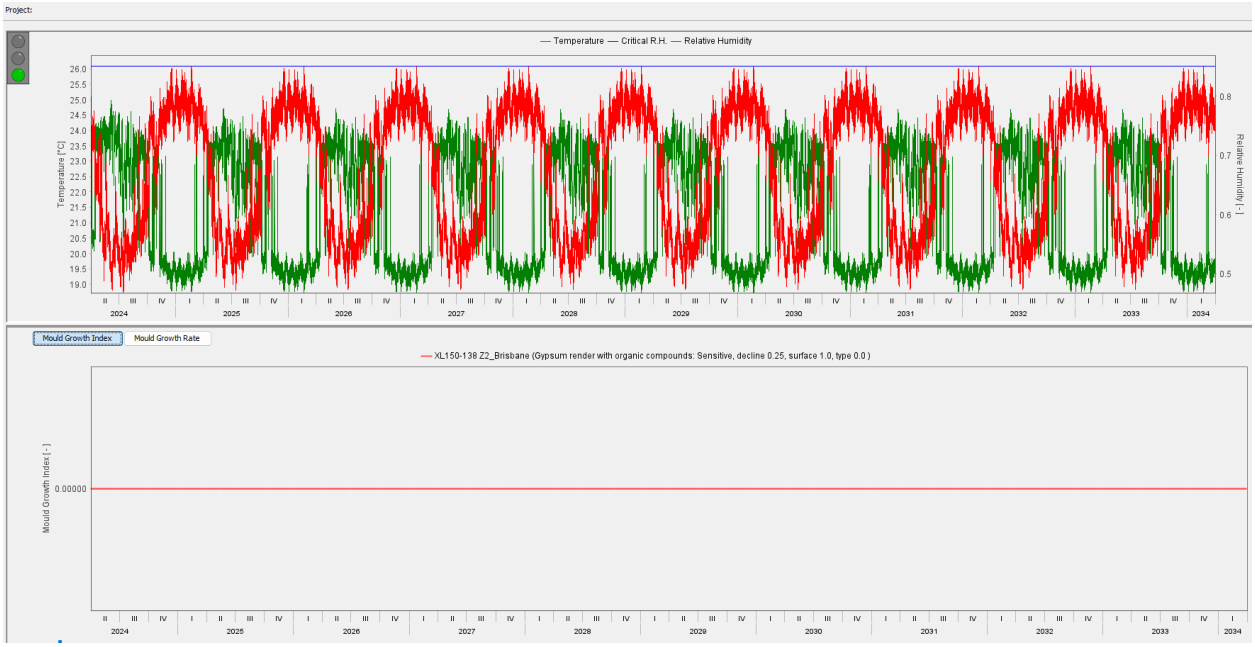


Figure 21 Mould growth Index at interior surface = 0 < 3 thus, OK

10.1.8.2 At air cavity (gypsum face)

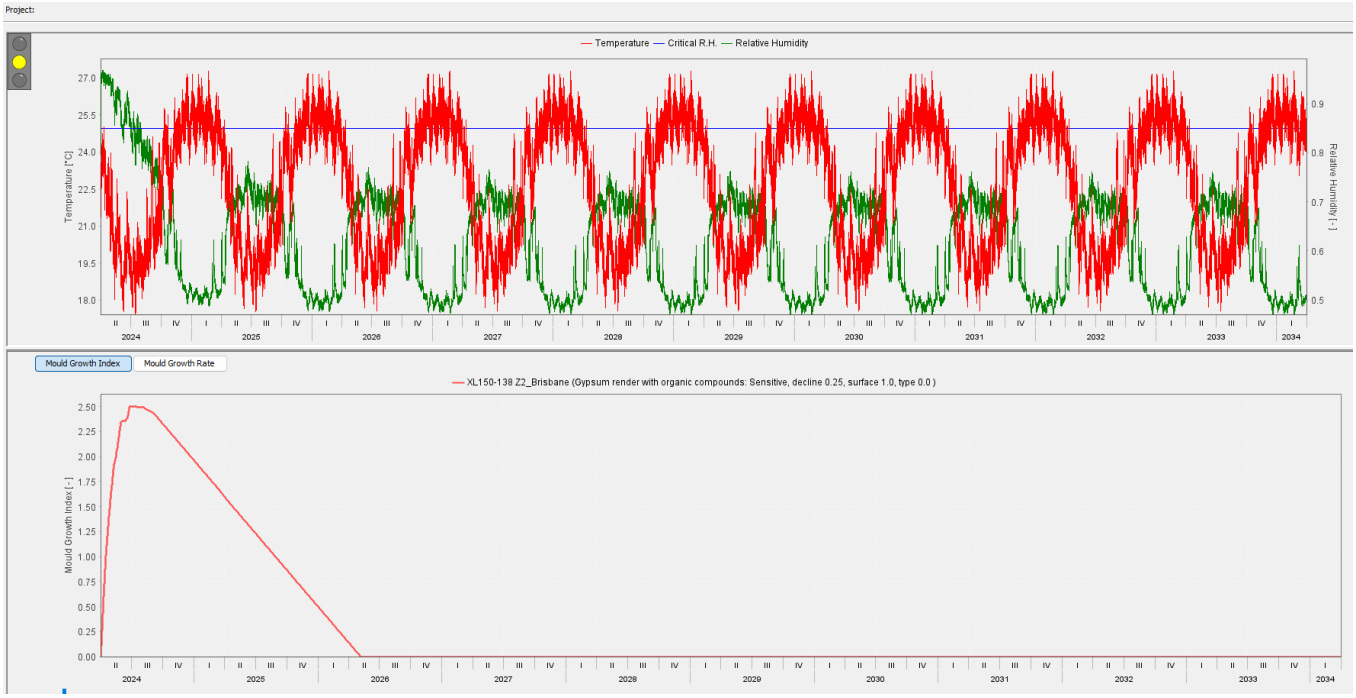


Figure 22 Mould growth Index at air cavity (gypsum face) = 2.5 < 3 thus, OK

10.1.8.3 At air cavity (Ritek Cement Board surface)

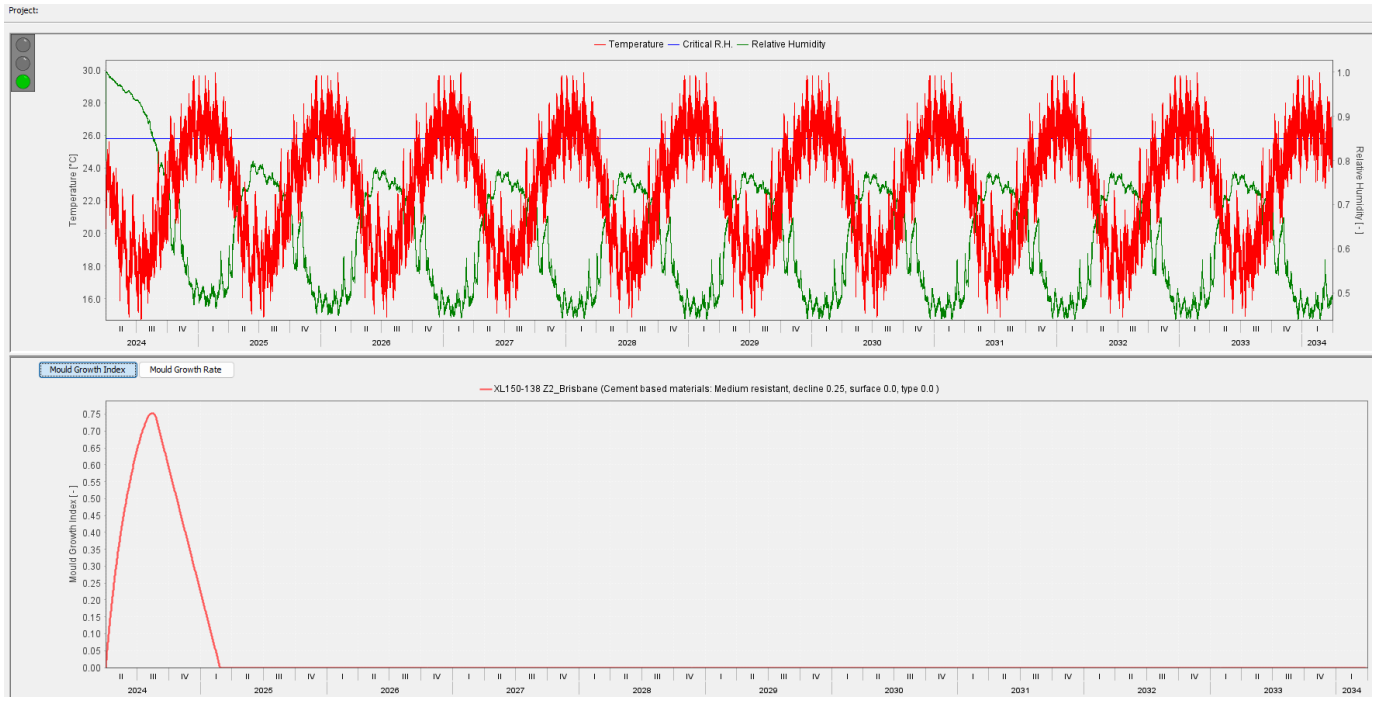


Figure 23 Mould growth Index at interior surface (Ritek Cement Board surface) = 0.75 < 3 thus, OK

10.1.9 Key Findings

WUFI analysis Model of 150mm X-PLUS Ritek wall system based on AIRAH DA07 & ASHRAE 160 standards, reveals low moisture levels and mould growth risk for internal elements under worst-case scenario. Key findings are described below:

- The Total Water Content (Cl.10.1.1) of the wall system is at pick during construction and reduces significantly in time. It also, fluctuates slightly with seasonal changes. There is no sign of moisture accumulation in any components of the wall during the 10-year model.
- Moisture levels (RH) within the internal plasterboard (Cl. 10.1.4) lining consistently stay below 85% relative humidity at construction phase and remains below 70% throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the air gap (Cl. 10.1.4) lining consistently stay below 95% relative humidity at construction phase and drops immediately and remains below 75% throughout the 10-years analysis period, which is within acceptable limits.
- The summary of post construction graph (Cl 10.1.6) shows finding below
    - RH never exceed 80% throughout 10 years study in Inner Fibre Cement Board, Air Gap and Plaster Board meaning the risk of condensation is “Low”.
    - Average RH is Approx. 60% for inner layers.
    - Average water content is very low for inner layers.
- DIN 4108 limits water content to 500 g/m^2 at interfaces where at least one layer is non-capillary active. The water content in the plaster board ay cavity gap (Cl. 10.1.3) is calculated approx. 100 g/m^2. Thus, the risk of condensate is categorised as “Low”.
- The Mould Growth index (Cl. 10.2.8) always remain below 3 at internal and cavity surfaces which satisfy the requirements of NCC 2022, AIRAH DA07 & ASHRAE 160 standards.

10.2 Climate Zone 3

10.2.1 Total Water Content

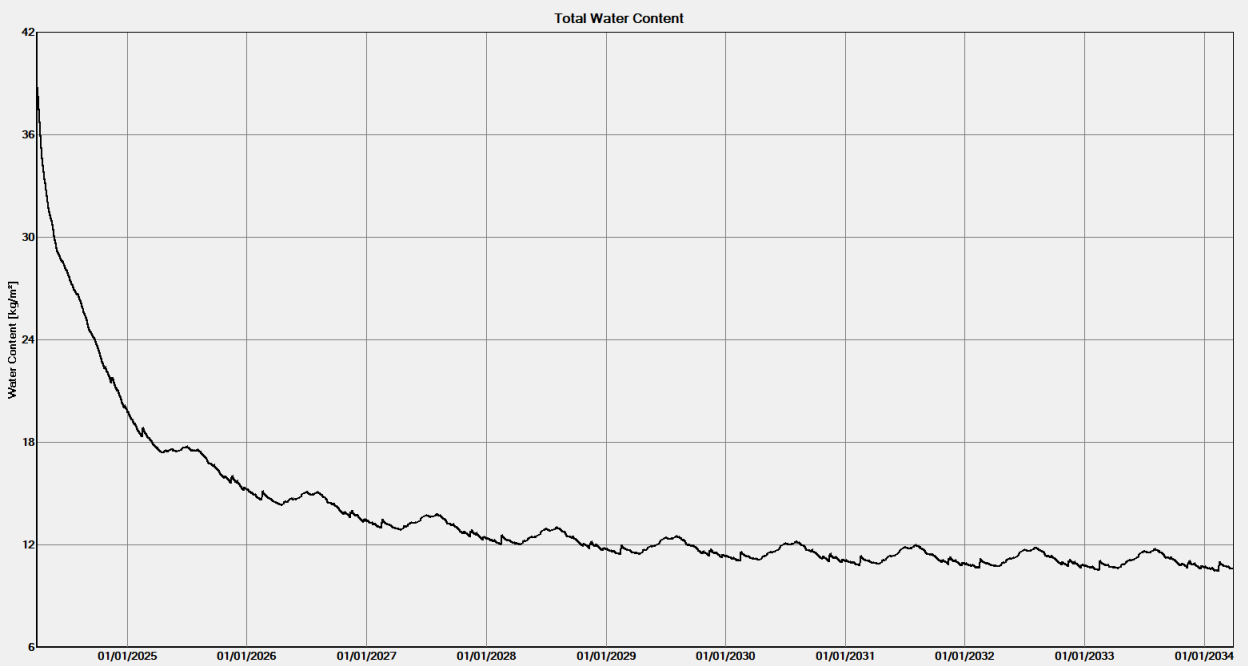


Figure 24 Total Water Content

10.2.2 Water Content at Gypsum (kg/m^3)

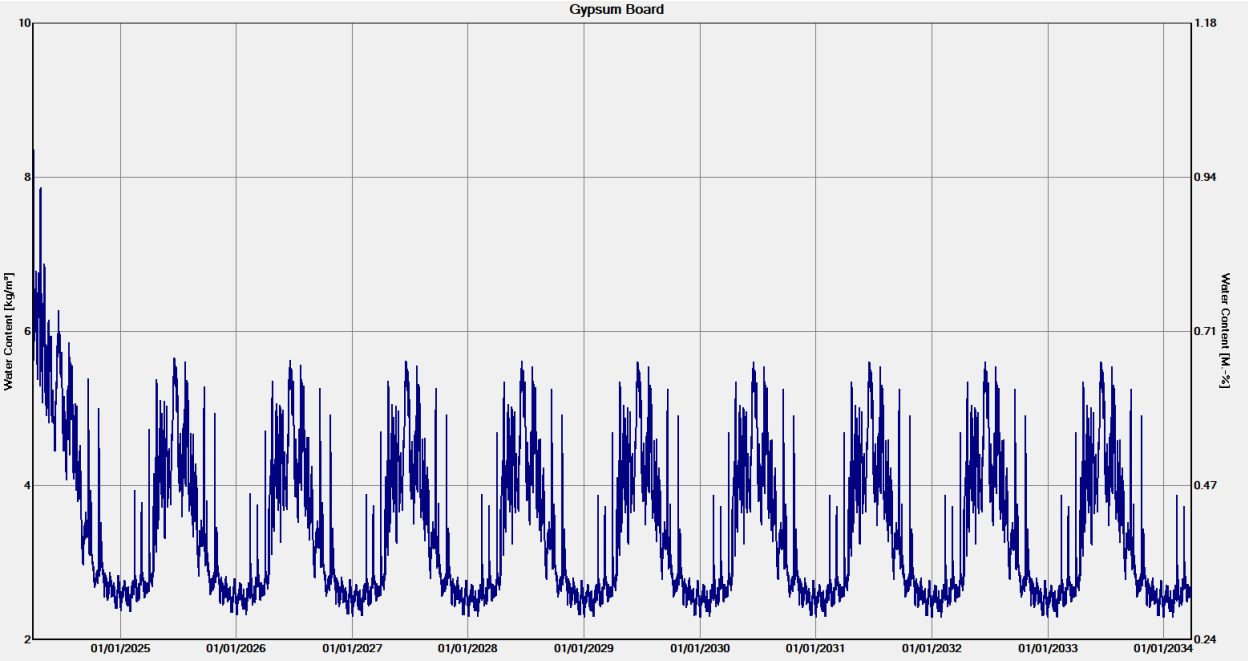


Figure 25 Water Content at Gypsum (kg/m3)

10.2.3 Water Content at Air Gap & Plaster Board (kg/m²)

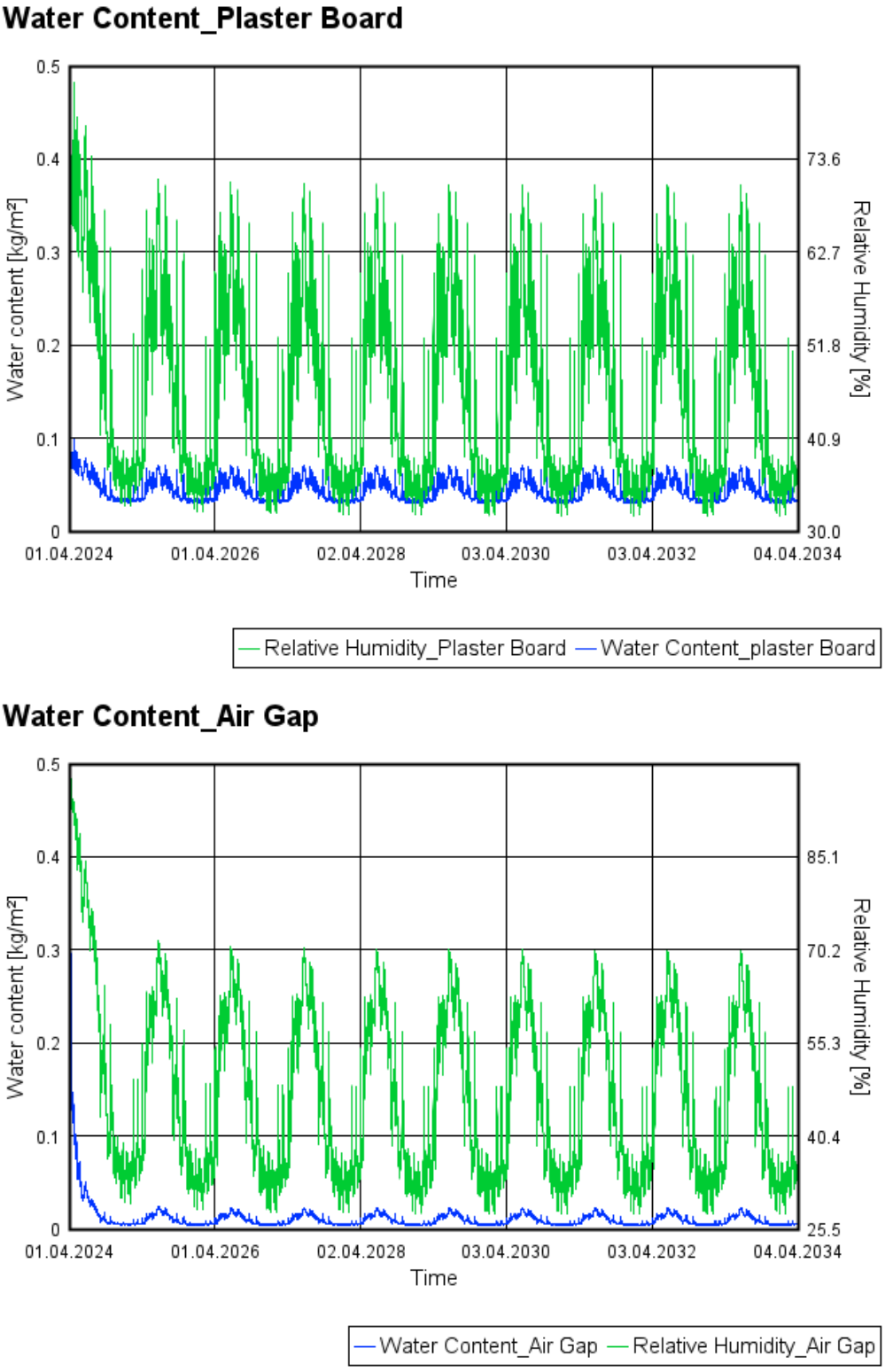
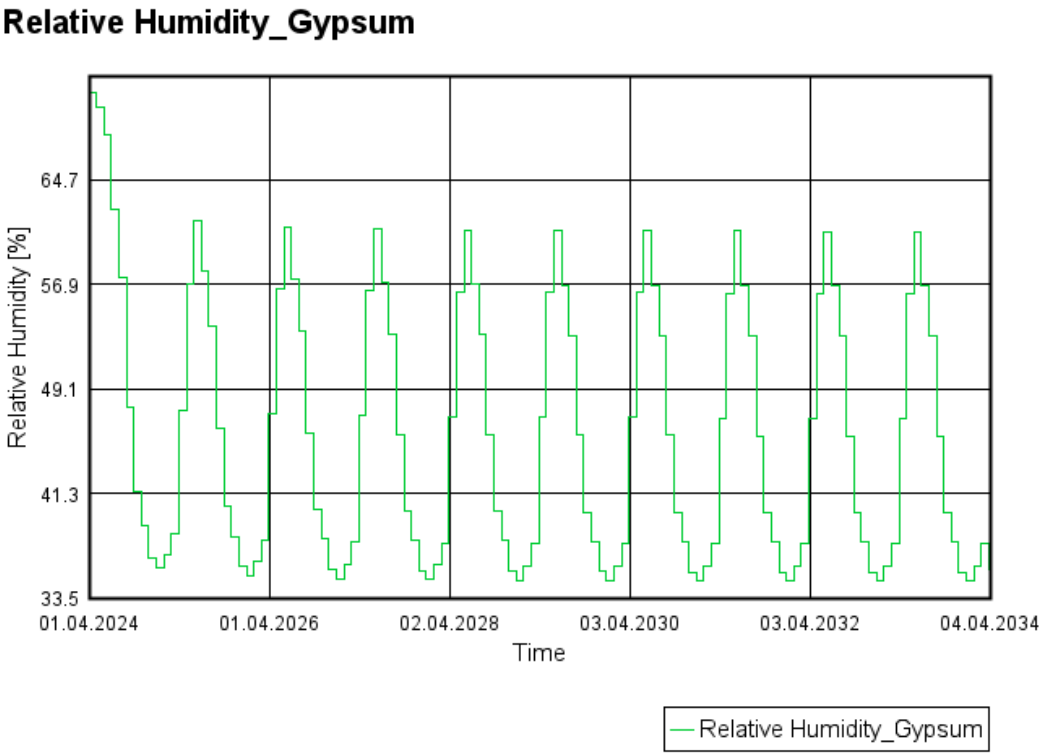


Figure 26 Water Content at Air Gap & Plaster Board (kg/m2)

10.2.4 Relative Humidity at Air Gap & Plaster



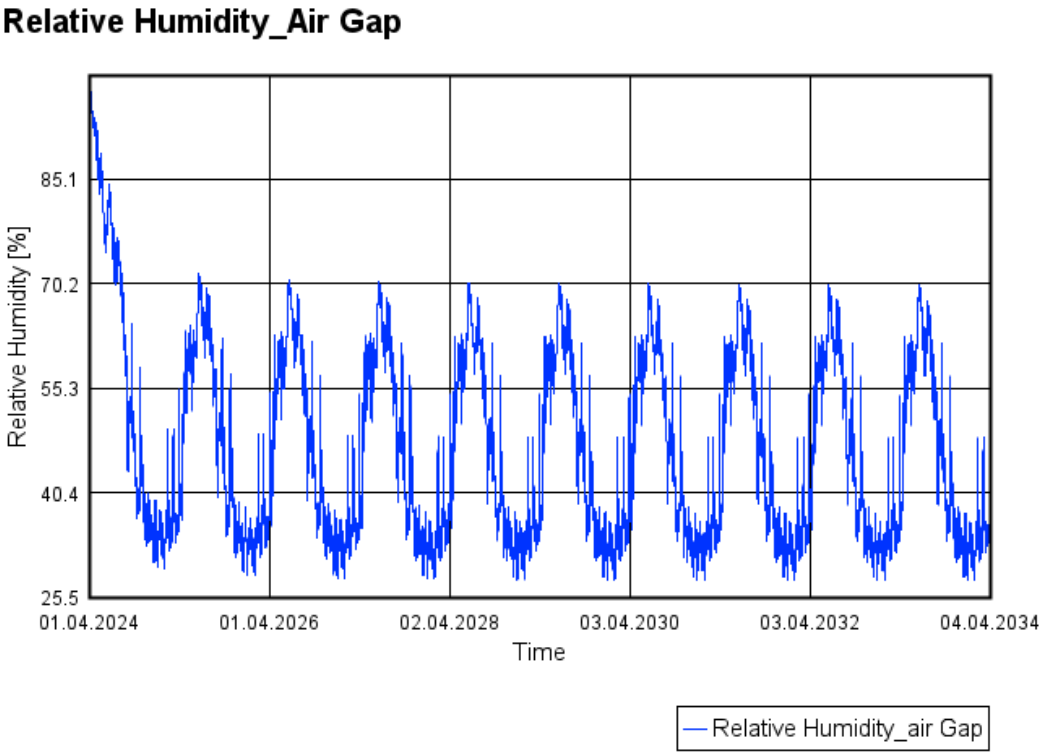


Figure 27 Relative Humidity at Air Gap & Plaster

10.2.5 Internal Temperature Vs. Dew point at the Interior Surface

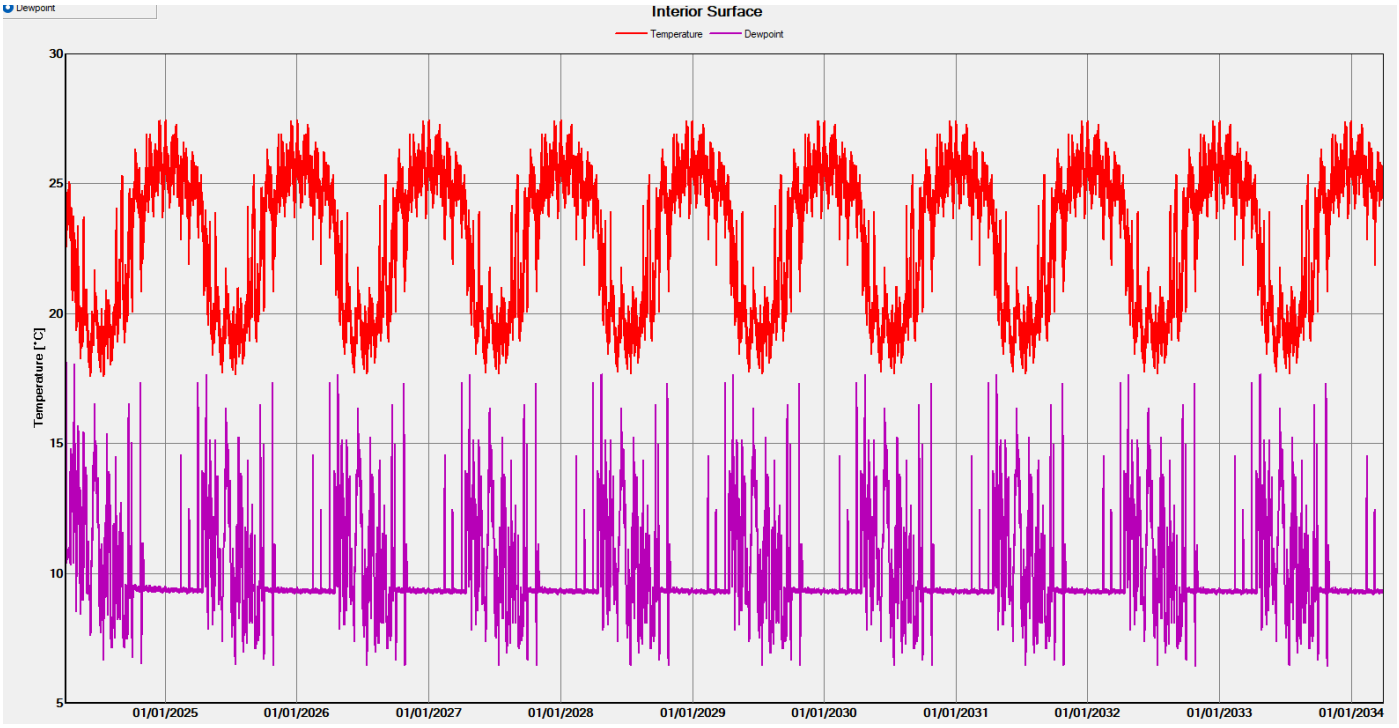


Figure 28 Internal Temperature does not exceed dew point

10.2.6 Summary of Temperature, Water Content and Relative Humidity (Post-Construction)

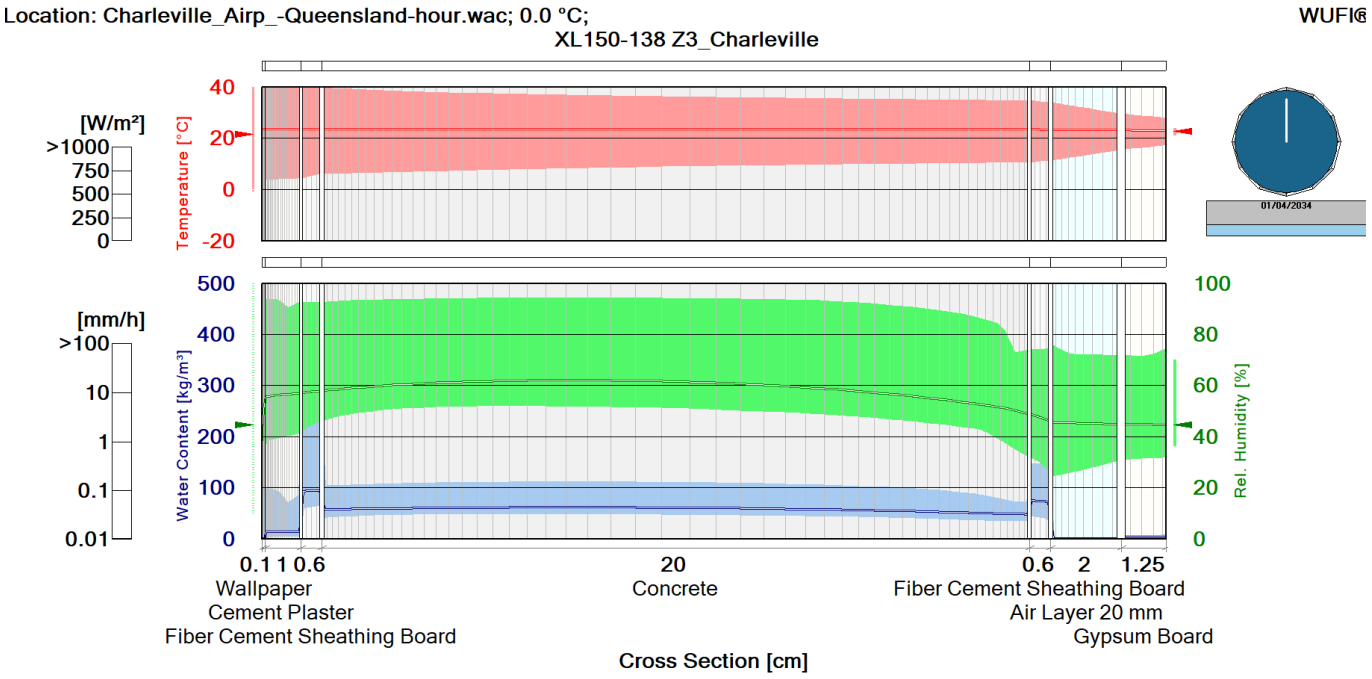


Figure 29 Average of Temperature, Water Content and Relative Humidity (Post-Construction)

10.2.7 Relative humidity (mould growth risk) at the Interior Surface

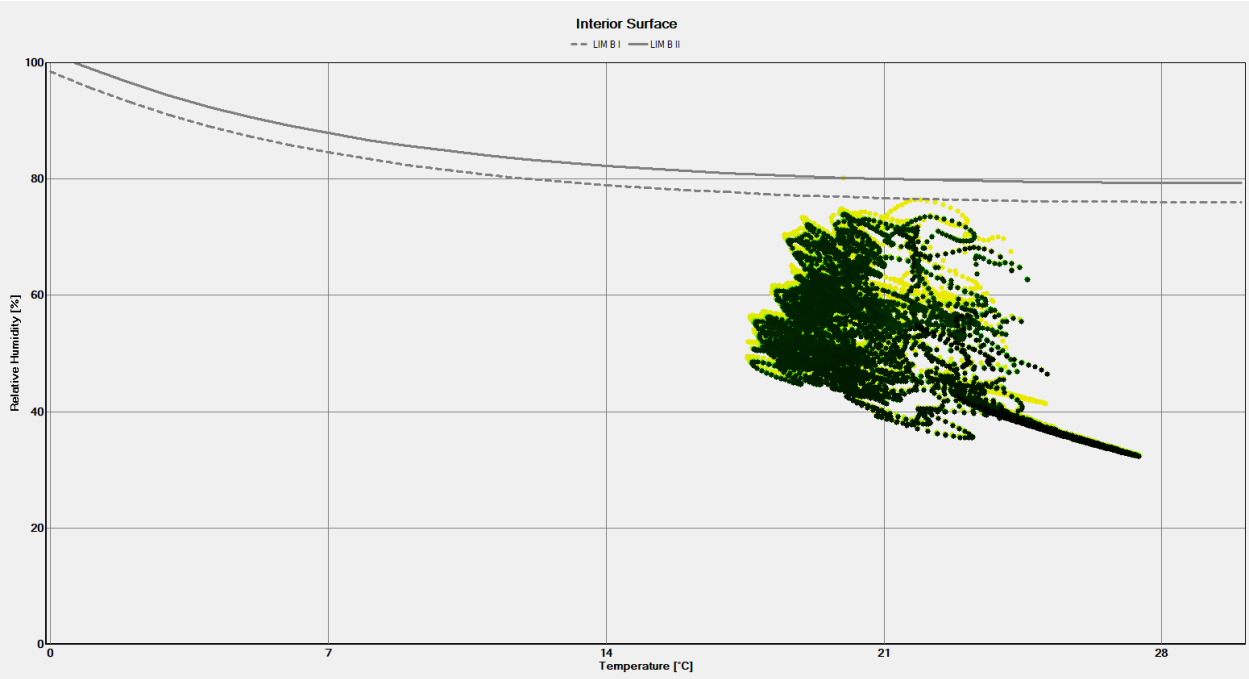


Figure 30 Post Construction <80%. No risk of mould growth at interior face

10.2.8 Mould Growth Risk

10.2.8.1 At Interior Surface

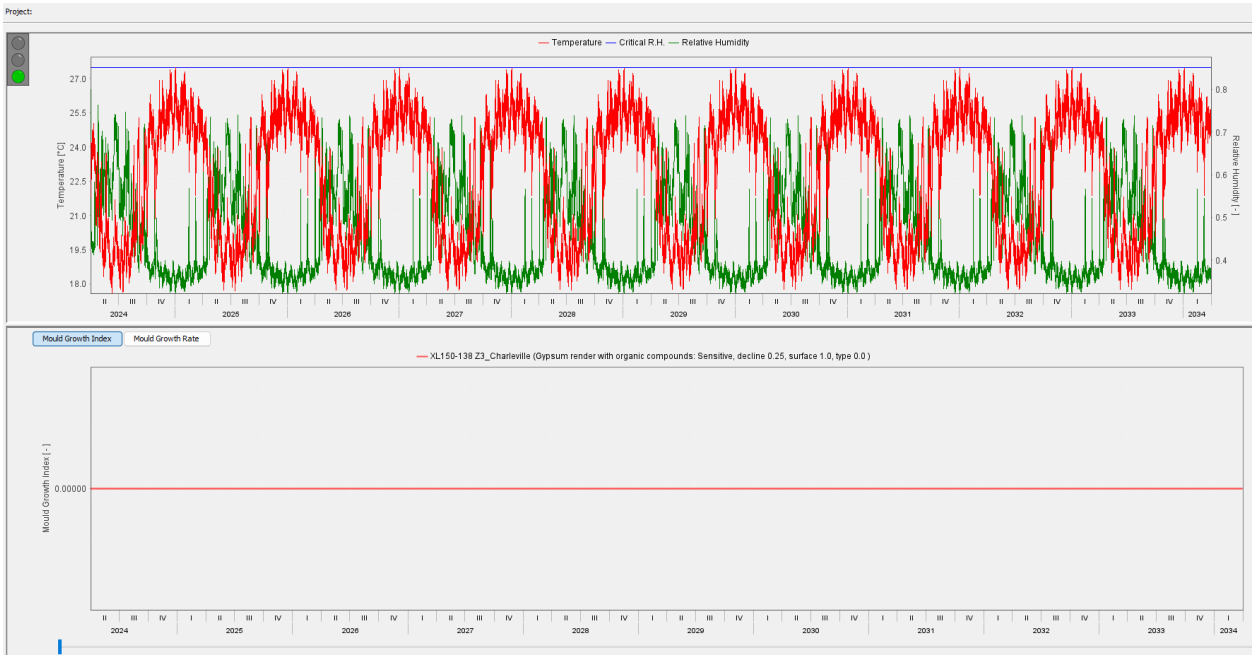


Figure 31 Mould growth Index at interior surface = 0 < 3 thus, OK

10.2.8.2 At air cavity (gypsum face)

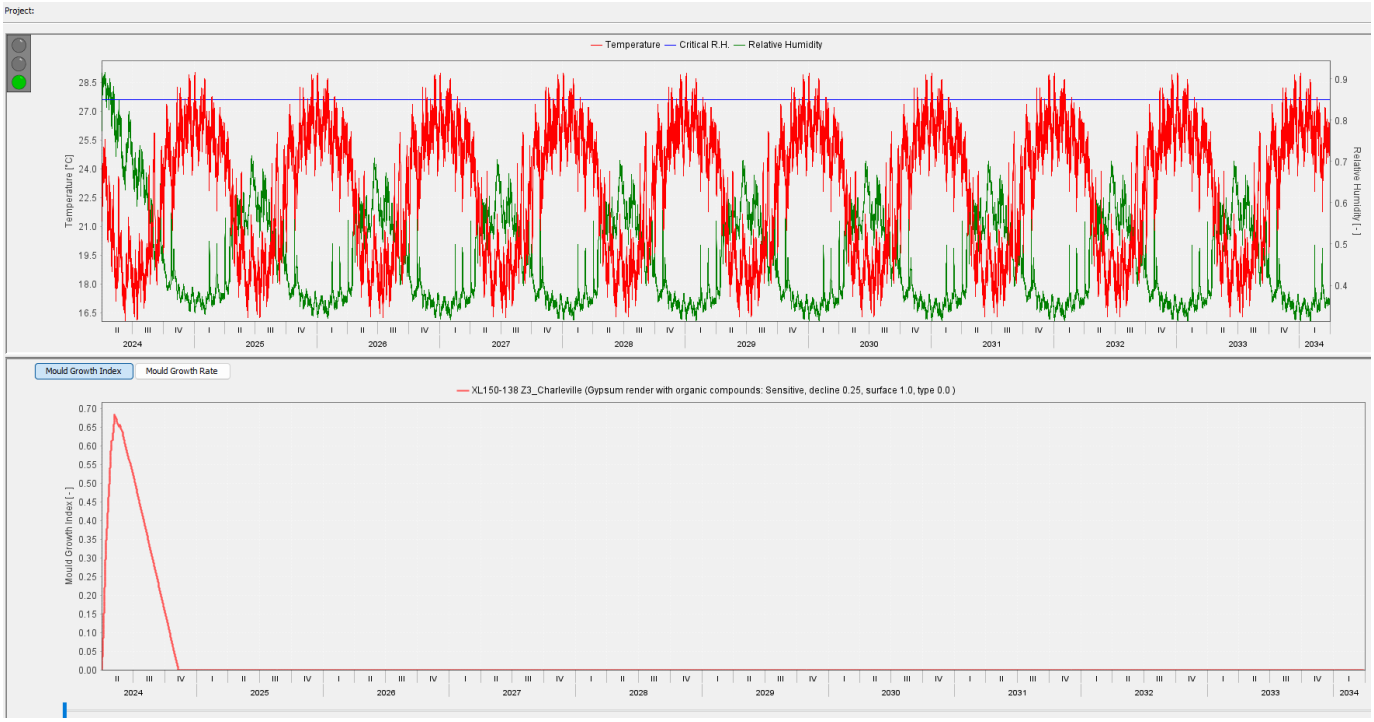


Figure 32 Mould growth Index at air cavity (gypsum face) = 0.70 < 3 thus, OK

10.2.8.3 At air cavity (Ritek Cement Board surface)

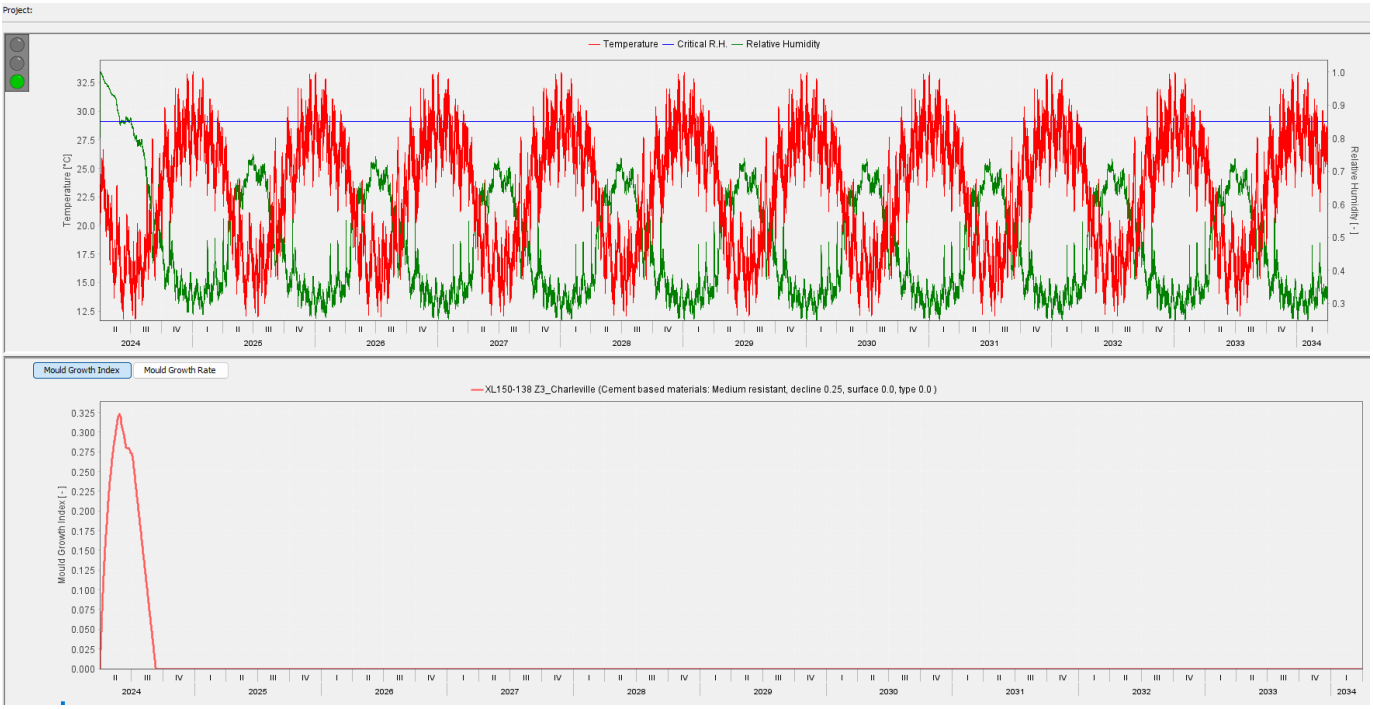


Figure 33 Mould growth Index at interior surface (Ritek Cement Board surface) = 0.33 < 3 thus, OK

10.2.9 Key Findings

WUFI analysis Model of 150mm X-PLUS Ritek wall system based on AIRAH DA07 & ASHRAE 160 standards, reveals low moisture levels and mould growth risk for internal elements under worst-case scenario. Key findings are described below:

- The Total Water Content (Cl.10.2.1) of the wall system is at pick during construction and reduces significantly in time. It also, fluctuates slightly with seasonal changes. There is no sign of moisture accumulation in any components of the wall during the 10-year model.
- Moisture levels (RH) within the internal plasterboard (Cl. 10.2.4) lining consistently stay below 75% relative humidity at construction phase and remains below 60% throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the air gap (Cl. 10.2.4) lining consistently stay below 85% relative humidity at construction phase and drops immediately and remains below 70% throughout the 10-years analysis period, which is within acceptable limits.
- The summary of post construction graph (Cl 10.2.6) shows finding below
    - RH never exceed 75% throughout 10 years study in Inner Fibre Cement Board, Air Gap and Plaster Board meaning the risk of condensation is “Low”.
    - Average RH is Approx. 45% for inner layers.
    - Average water content is very low for inner layers.
- DIN 4108 limits water content to 500 g/m^2 at interfaces where at least one layer is non-capillary active. The water content in the plaster board ay cavity gap (Cl. 10.2.3) is calculated approx. 150 g/m^2. Thus, the risk of condensate is categorised as “Low”.
- The Mould Growth index (Cl. 10.2.8) always remain below 3 at internal and cavity surfaces which satisfy the requirements of NCC 2022, AIRAH DA07 & ASHRAE 160 standards.

10.3 Climate Zone 5

10.3.1 Total Water Content

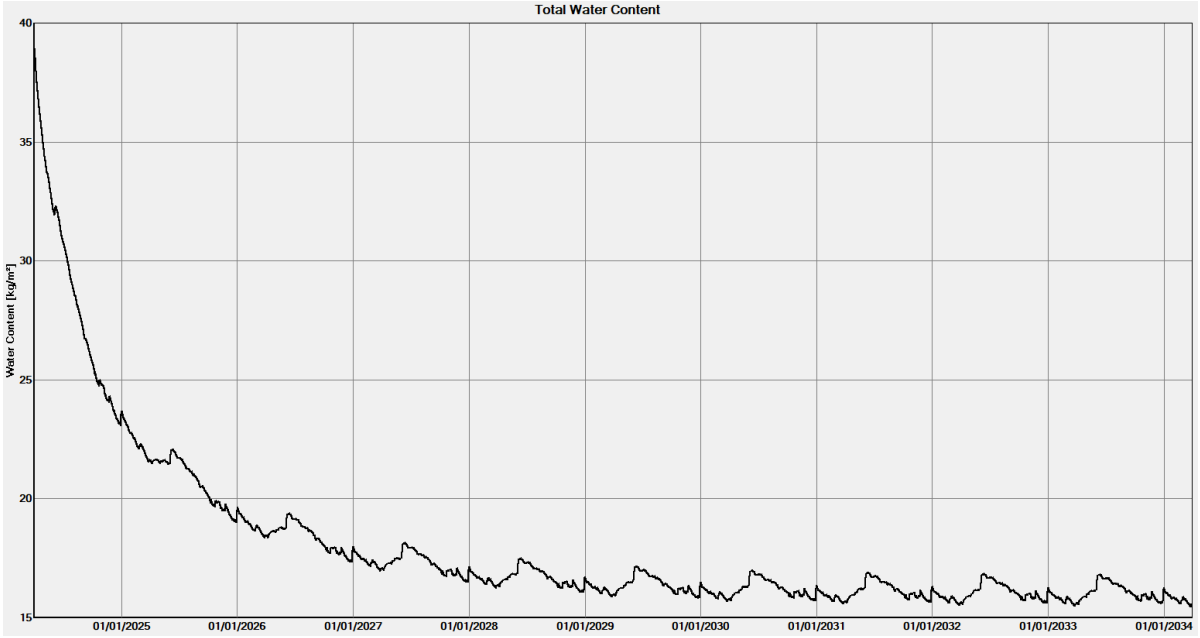


Figure 34 Total Water Content

10.3.2 Water Content at Gypsum (kg/m^3)

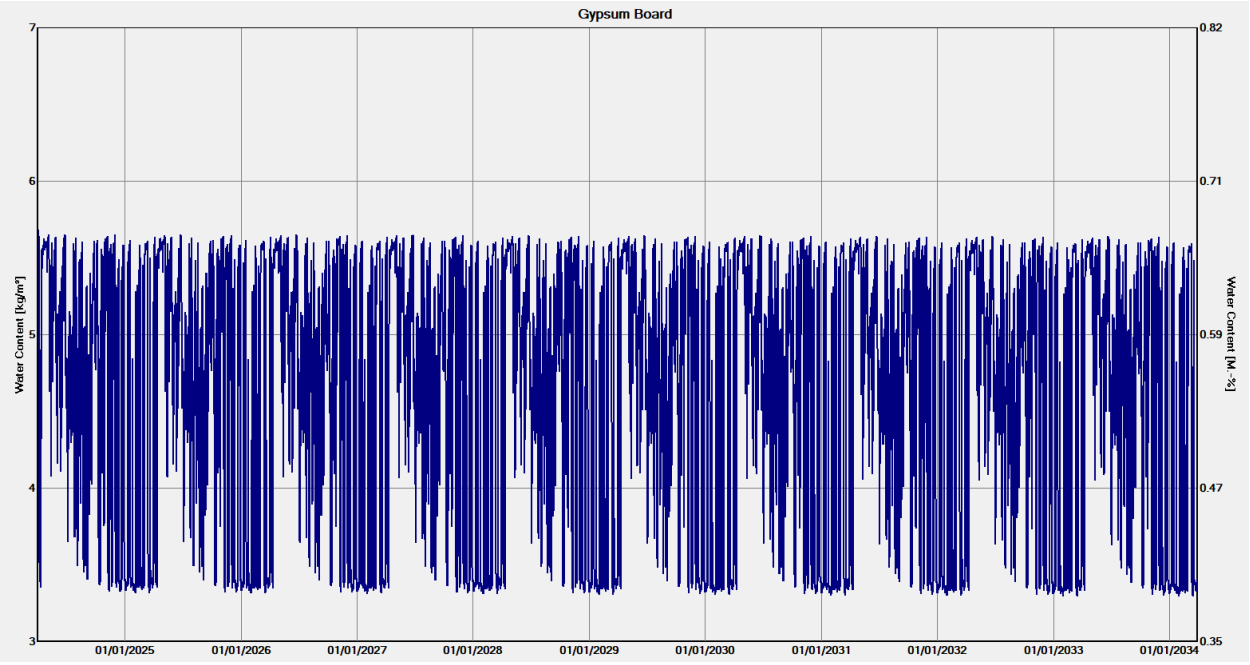


Figure 35 Water Content at Gypsum (kg/m3)

10.3.3 Water Content at Insulation, Air Gap & Plaster Board (kg/m^2)

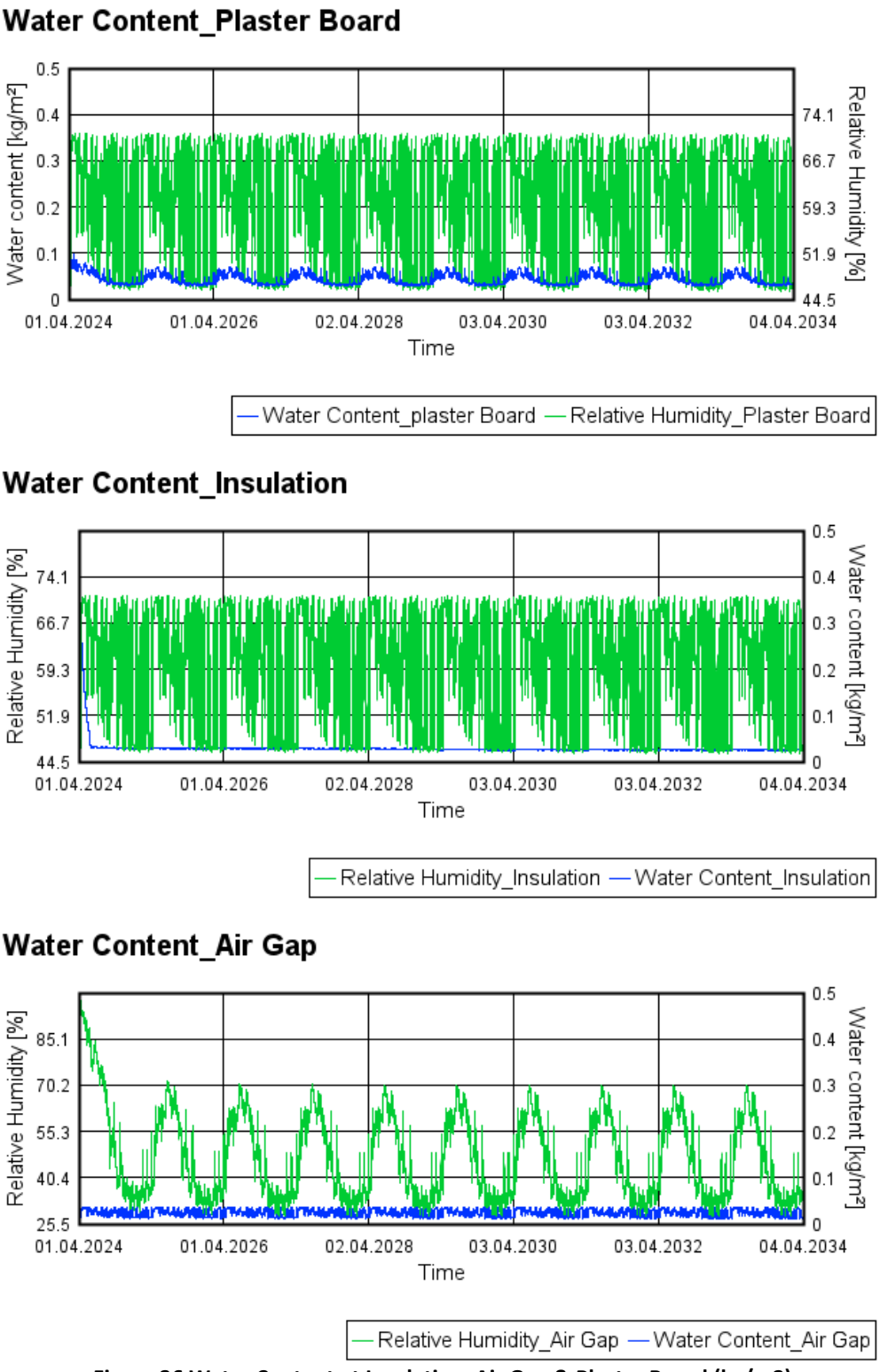


Figure 36 Water Content at Insulation, Air Gap & Plaster Board (kg/m2)

10.3.4 Relative Humidity at Insulation, Air Gap & Plaster

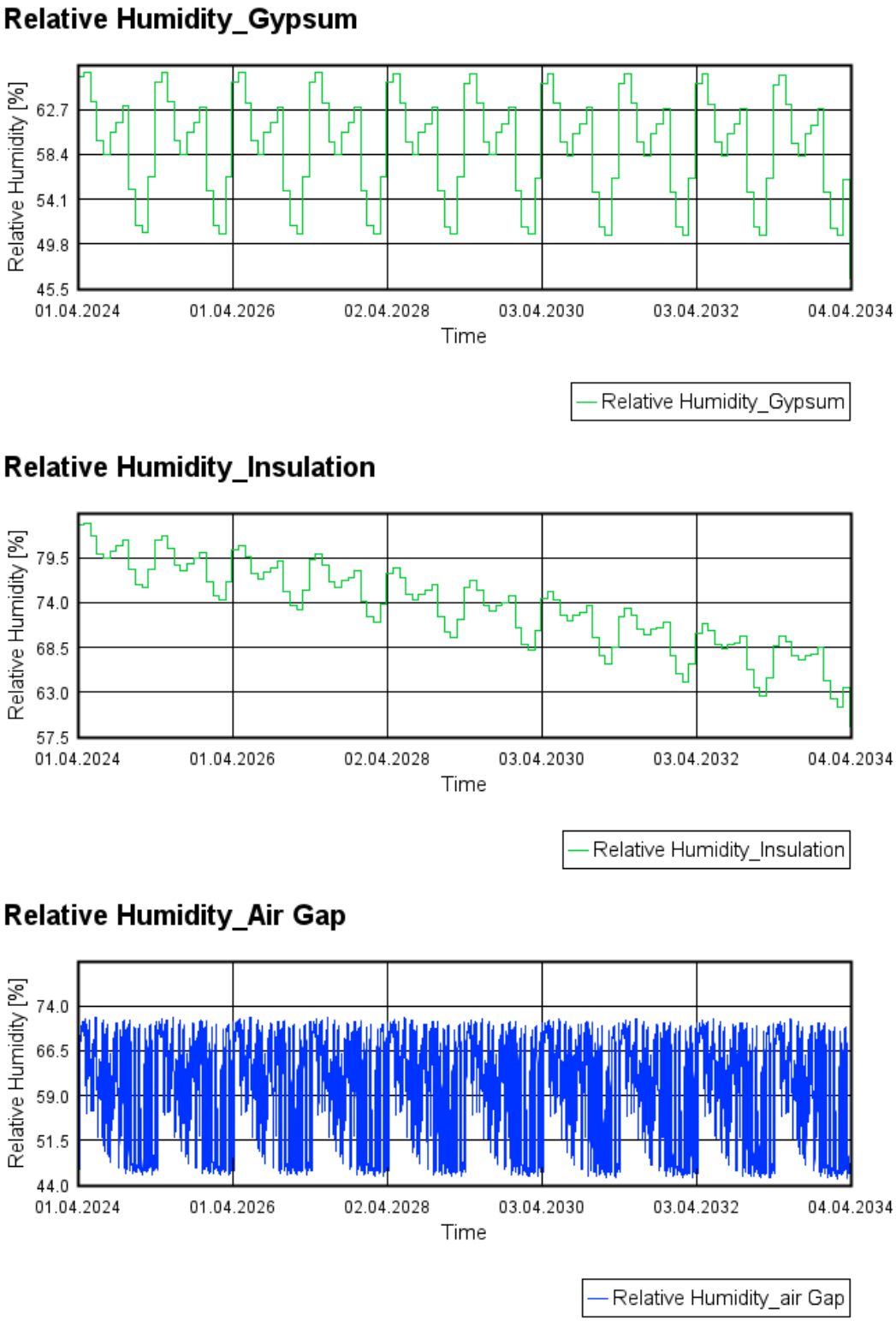


Figure 37 Relative Humidity at Insulation, Air Gap & Plaster

10.3.5 Internal Temperature Vs. Dew point at the Interior Surface

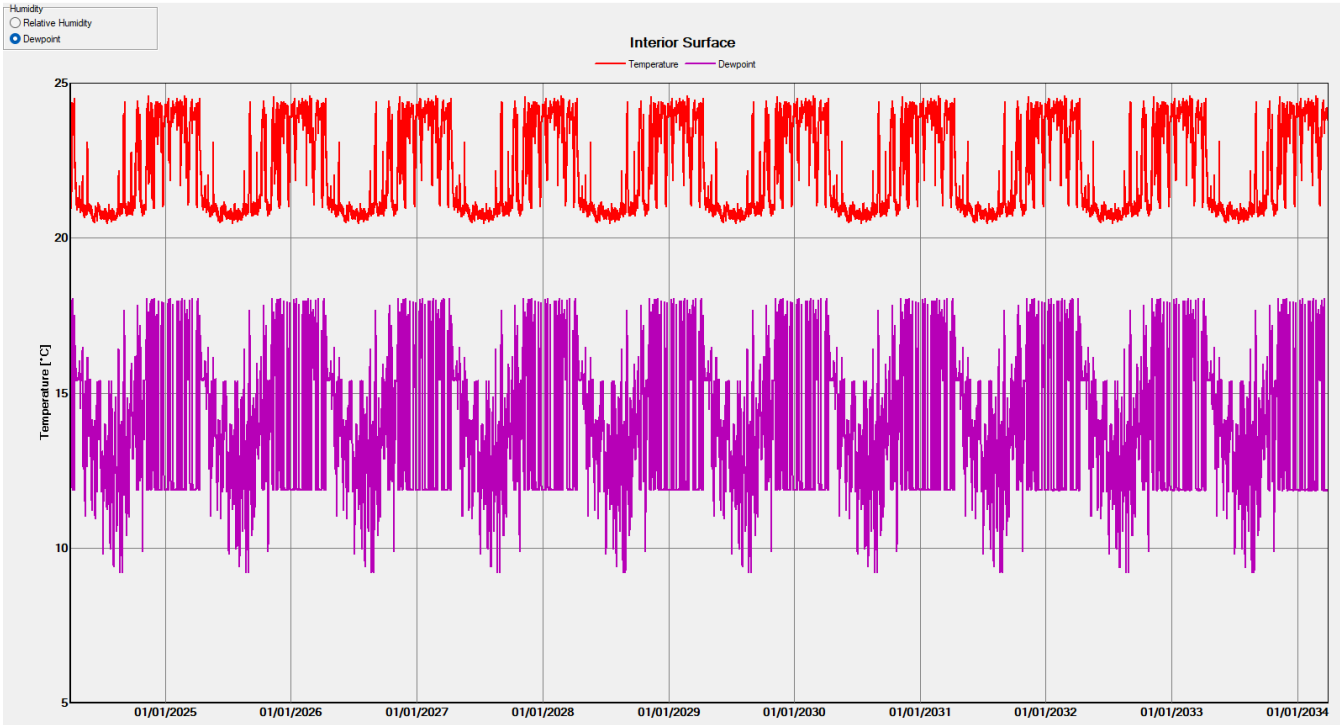


Figure 38 Internal Temperature does not exceed dew point

10.3.6 Summary of Temperature, Water Content and Relative Humidity (Post-Construction)

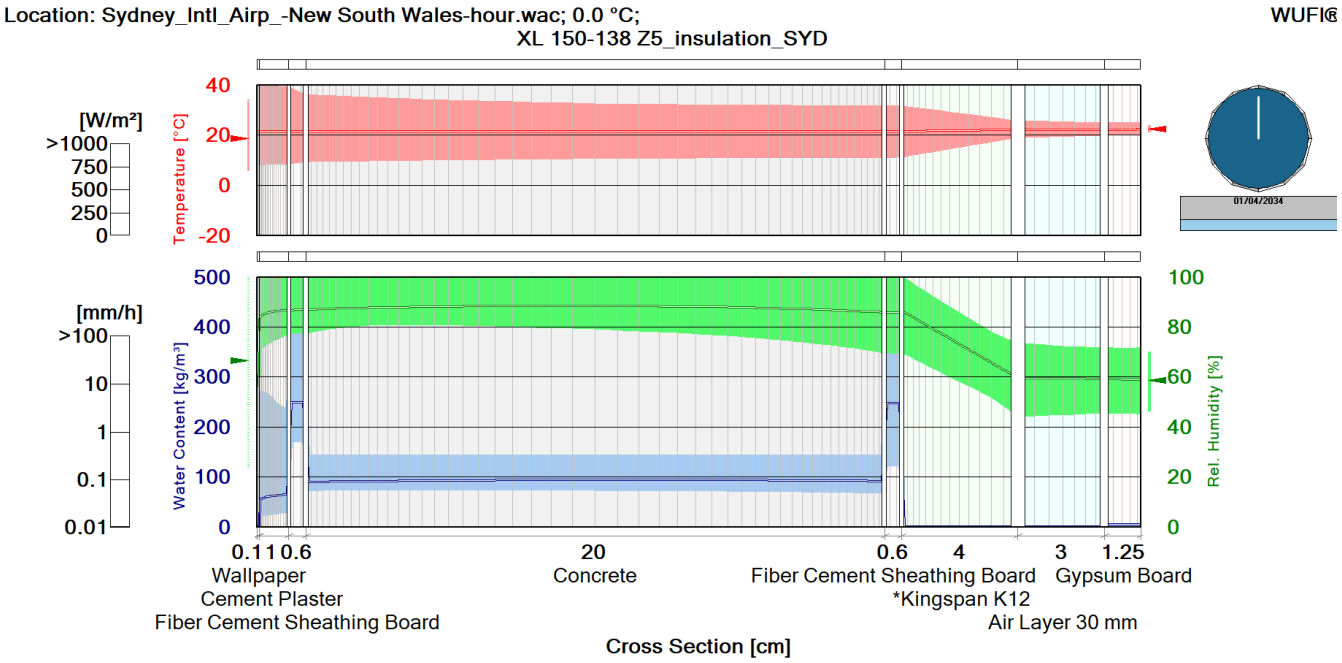


Figure 39 Average of Temperature, Water Content and Relative Humidity (Post-Construction)

10.3.7 Relative humidity (mould growth risk) at the Interior Surface

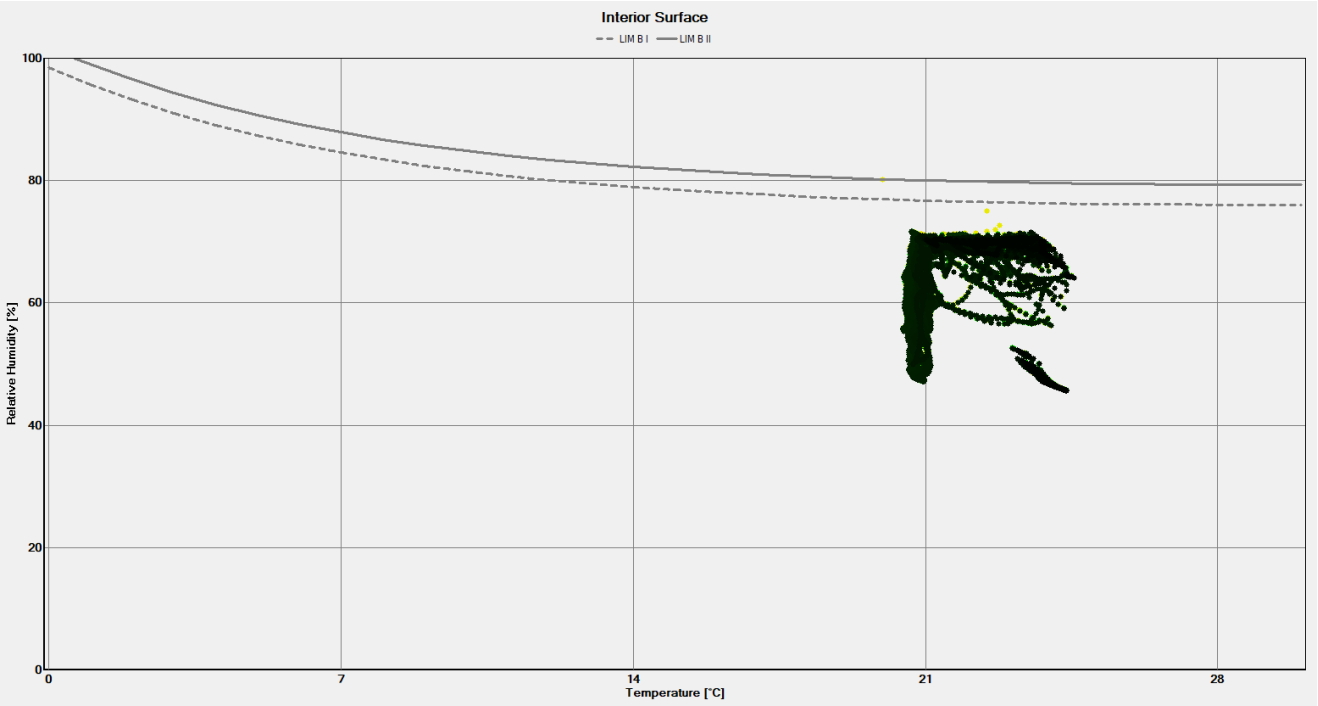


Figure 40 Post Construction <80%. No risk of mould growth at interior face

10.3.8 Mould Growth Risk

10.3.8.1 At Interior Surface

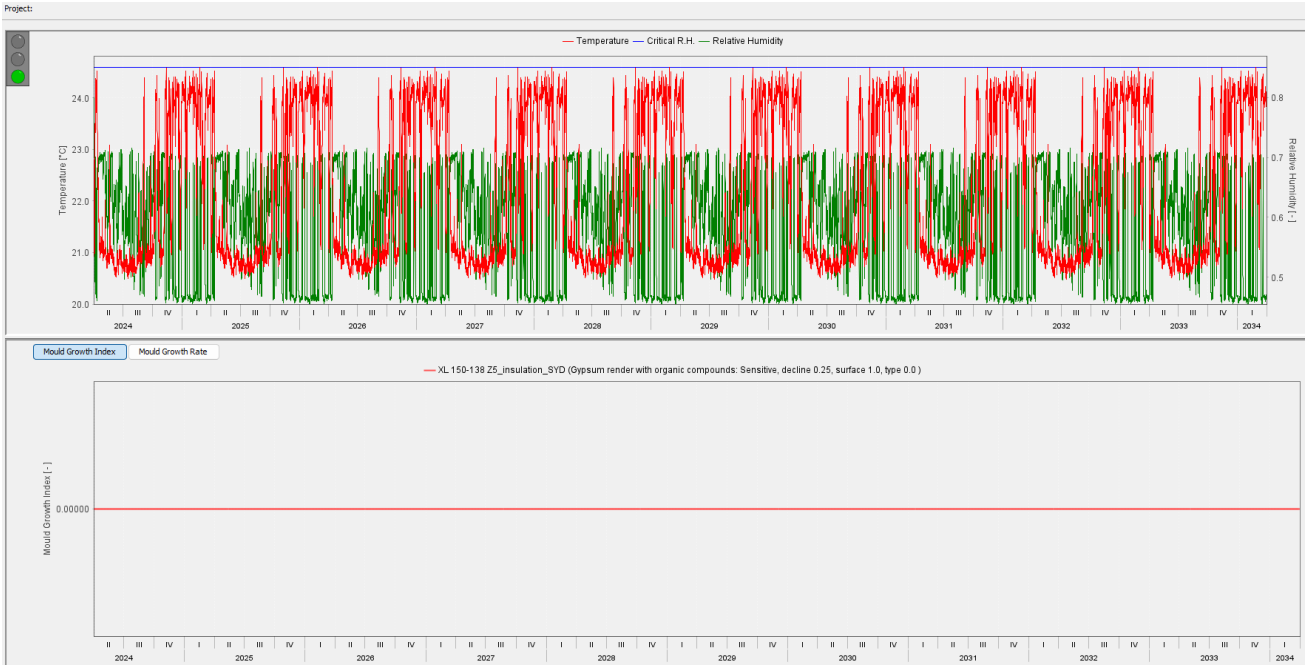


Figure 41 Mould growth Index at interior surface = 0 < 3 thus, OK

10.3.8.2 At air cavity (gypsum face)

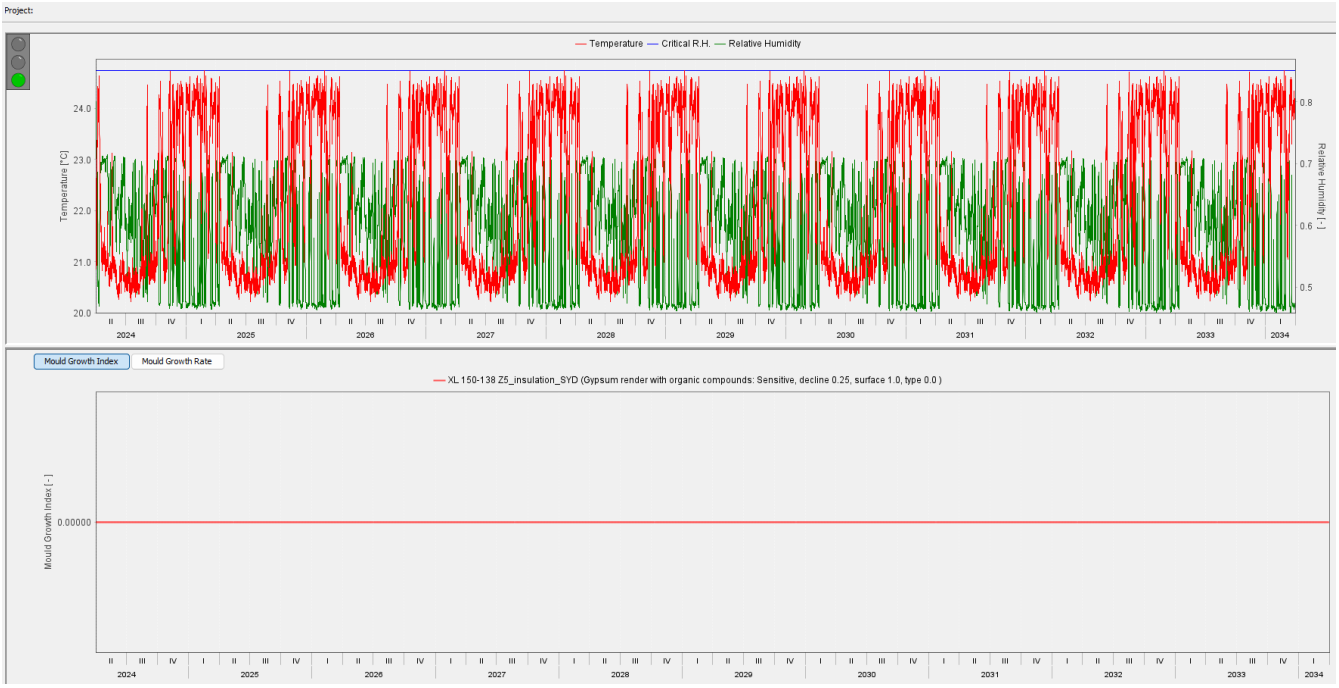


Figure 42 Mould growth Index at air cavity (gypsum face) = 0 < 3 thus, OK

10.3.8.3 At air cavity (Insulation face)

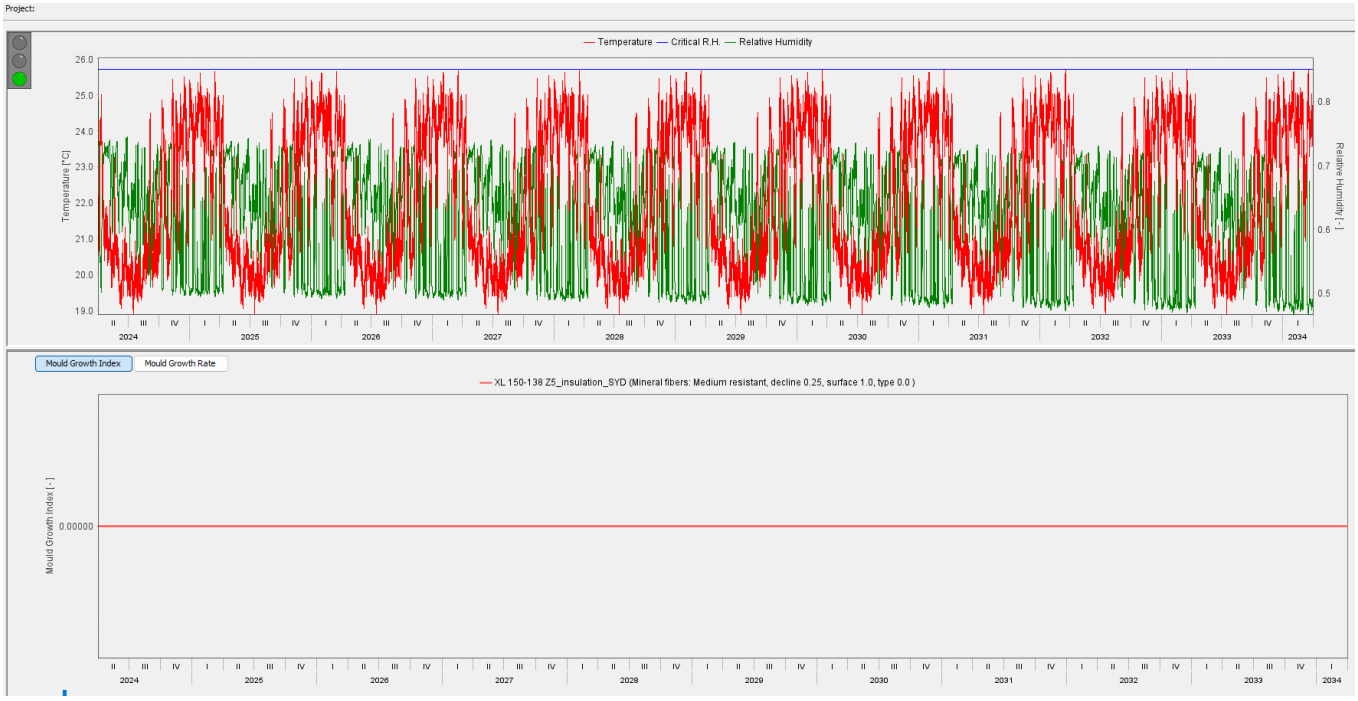


Figure 43 Mould growth Index at air cavity (Insulation face) = 0 < 3 thus, OK

10.3.8.4 At insulation (Ritek Cement Board surface) –During Construction

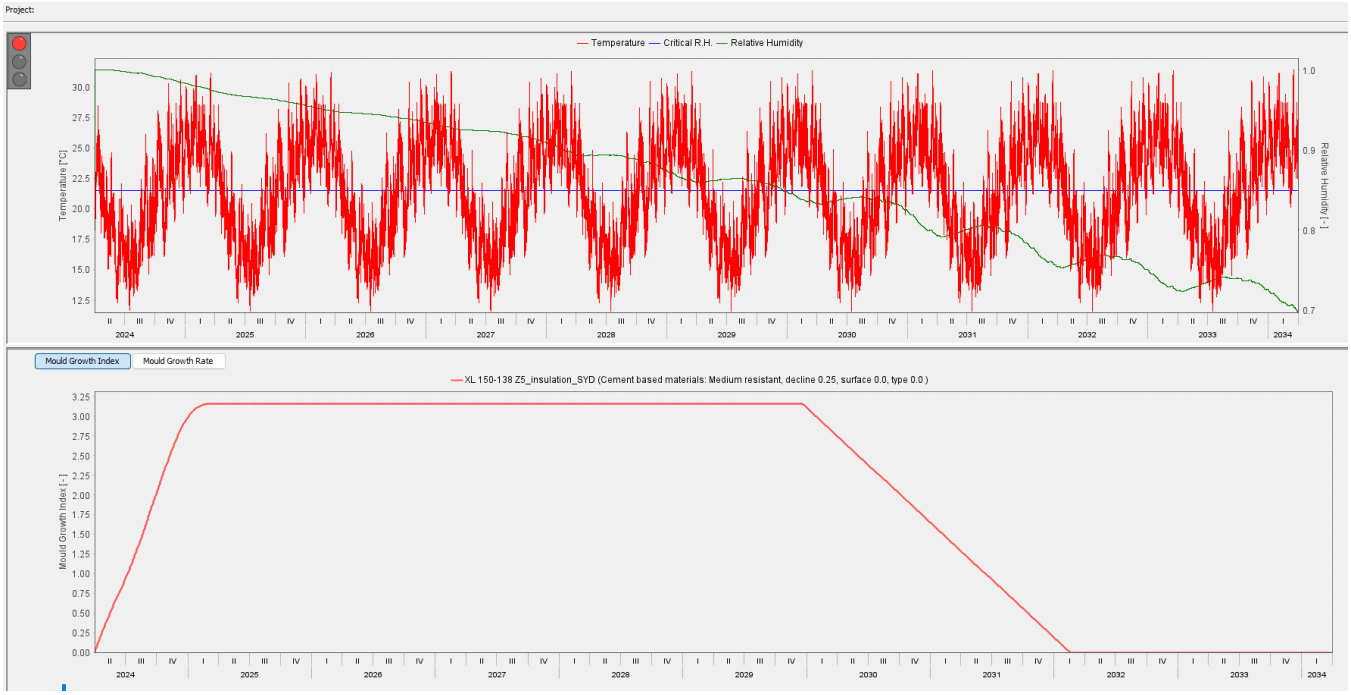


Figure 44 Mould growth Index at insulation surface (Ritek Cement Board surface) – post construction = 3.2 > 3 thus, NOT OK

10.3.8.5 At insulation (Ritek Cement Board surface) – Post Construction

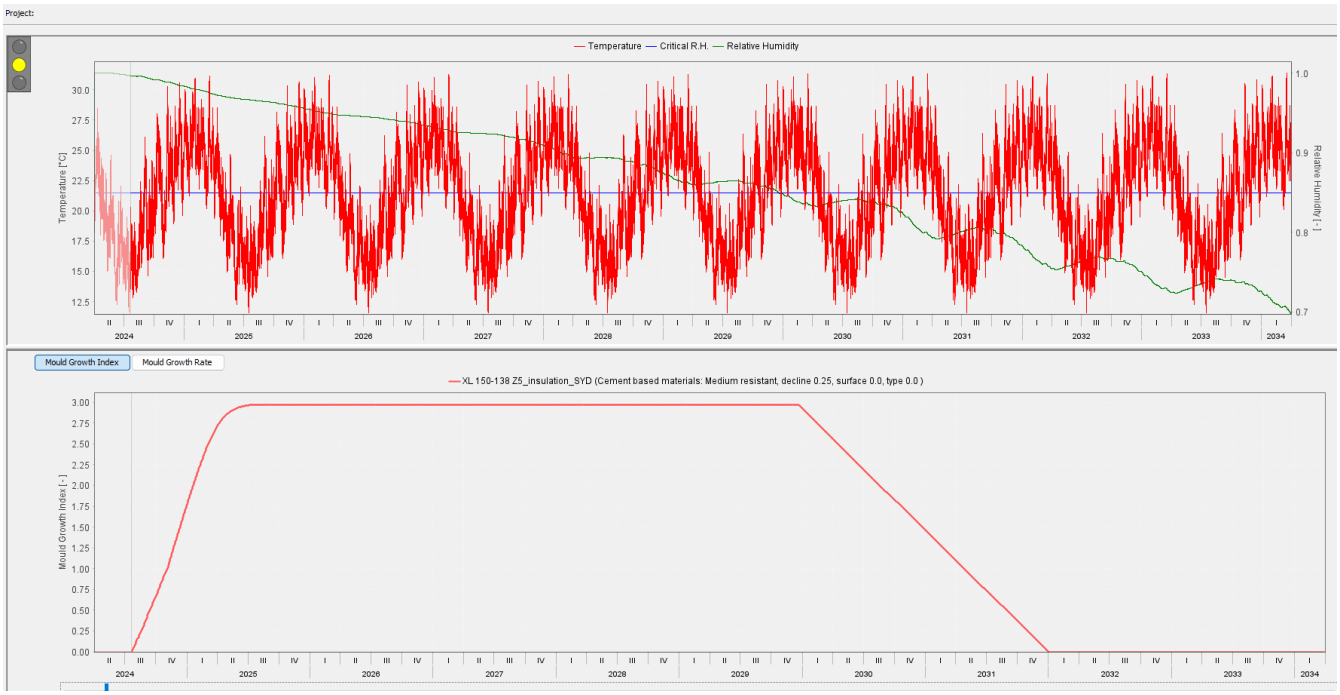


Figure 45 Mould growth Index at insulation surface (Ritek Cement Board surface) – post construction = 2.9 < 3 thus, OK

10.3.9 Key Findings

WUFI analysis Model of 150mm X-PLUS Ritek wall system based on AIRAH DA07 & ASHRAE 160 standards, reveals low moisture levels and mould growth risk for internal elements under worst-case scenario. Key findings are described below:

- The Total Water Content (Cl.10.3.1) of the wall system is at pick during construction and reduces significantly in time. It also, fluctuates slightly with seasonal changes. There is no sign of moisture accumulation in any components of the wall during the 10-year model.
- Moisture levels (RH) within the internal plasterboard (Cl. 10.3.4) lining consistently stay below 66% relative humidity throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the air gap (Cl. 10.3.4) lining consistently stay below 75% relative humidity throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the insulation layer (Cl. 10.3.4) lining consistently stay below 80% relative humidity at construction phase and reduces slowly throughout the 10-years analysis period, which is within acceptable limits.
- The summary of post construction graph (Cl 10.3.6) shows finding below
    - RH of Inner Fibre Cement Board and Insulation layer exceeds 80% at first but reduces gradually by time.
    - RH never exceed 80% throughout 10 years study in the Air Gap and Plaster Board meaning the risk of condensation is “Low”.
    - Average RH is Approx. 60% for the Air Gap and Plaster Board layers.
    - Average water content is very low for inner layers.
- DIN 4108 limits water content to 500 g/m^2 at interfaces where at least one layer is non-capillary active. The water content in the plaster board ay cavity gap (Cl. 10.3.3) is calculated approx. 100 g/m^2. Thus, the risk of condensate is categorised as “Low”.
- The Mould Growth index (Cl. 10.3.8.4) between Ritek wall and insulation (On Ritek wall fibre cement sheet) is 3.25 at first however, it drops immediately after construction phase and remains below 3 (Cl. 10.3.8.5).
- The Mould Growth index (Cl. 10.3.8) always remain below 3 at internal and air cavity surfaces which satisfy the requirements of NCC 2022, AIRAH DA07 & ASHRAE 160 standards.

Address: Level M 394 Lane Cove Rd
Macquarie Park NSW 2113
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10.4 Climate Zone 6

10.4.1 Total Water Content

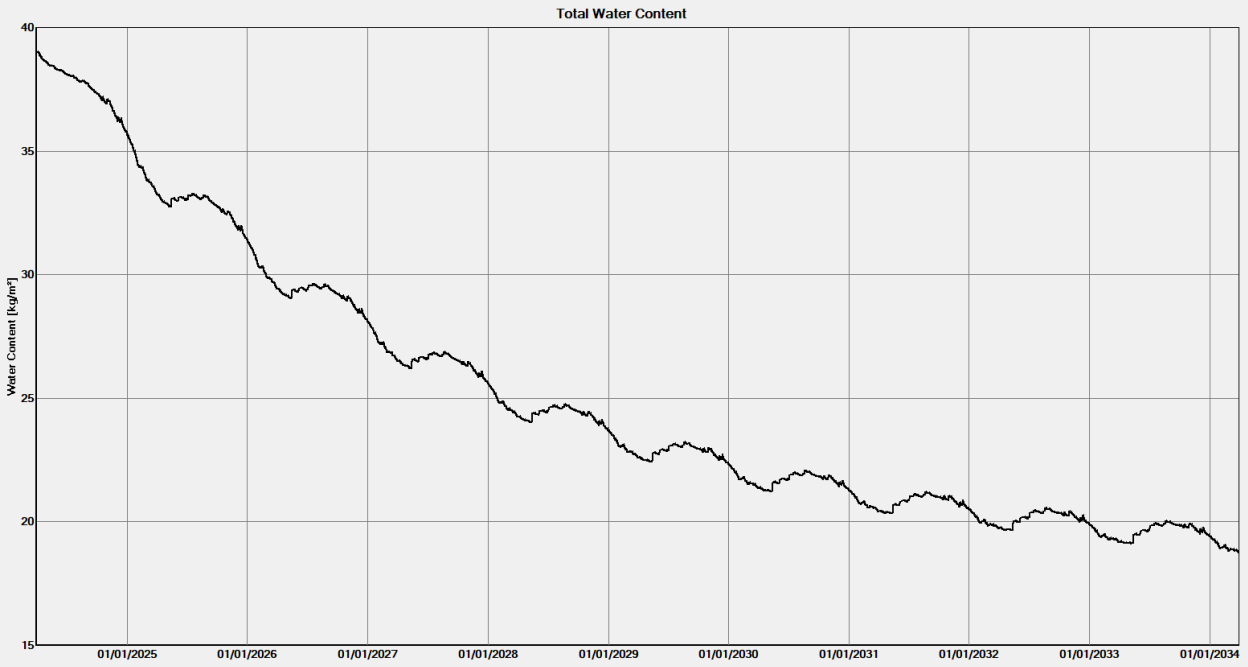


Figure 46 Total Water Content

10.4.2 Water Content at Gypsum (kg/m^3)

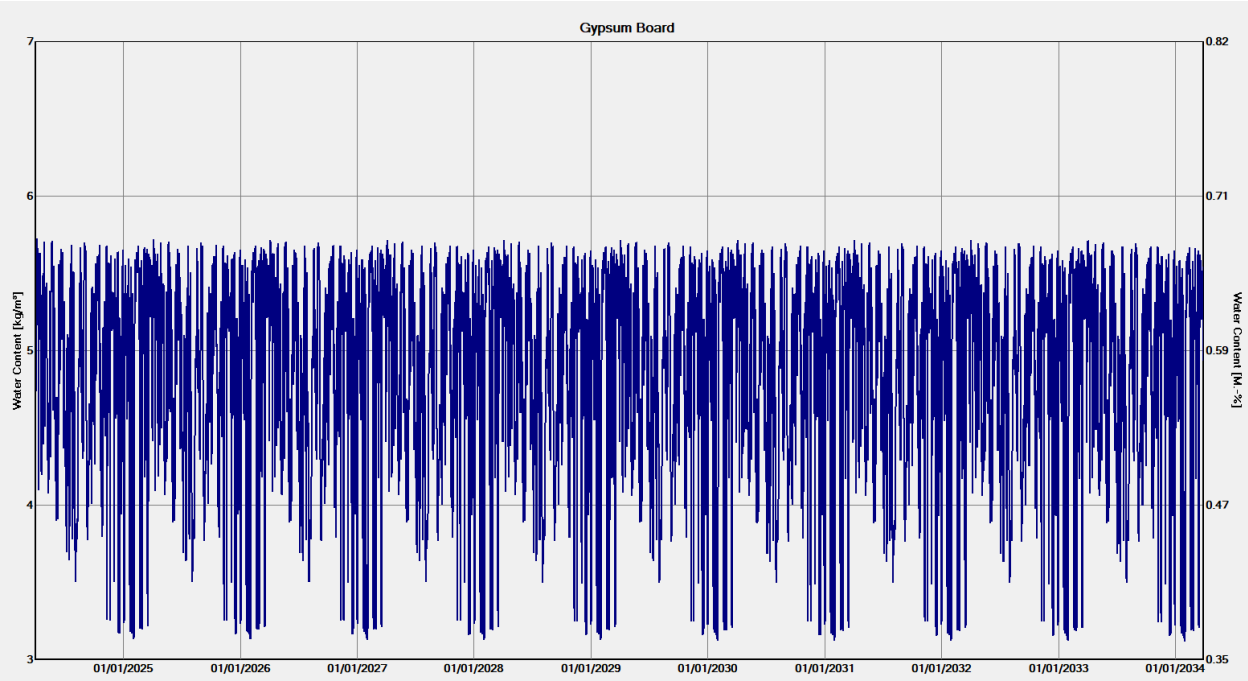


Figure 47 Water Content at Gypsum (kg/m3)

10.4.3 Water Content at Insulation, Air Gap & Plaster Board (kg/m^2)

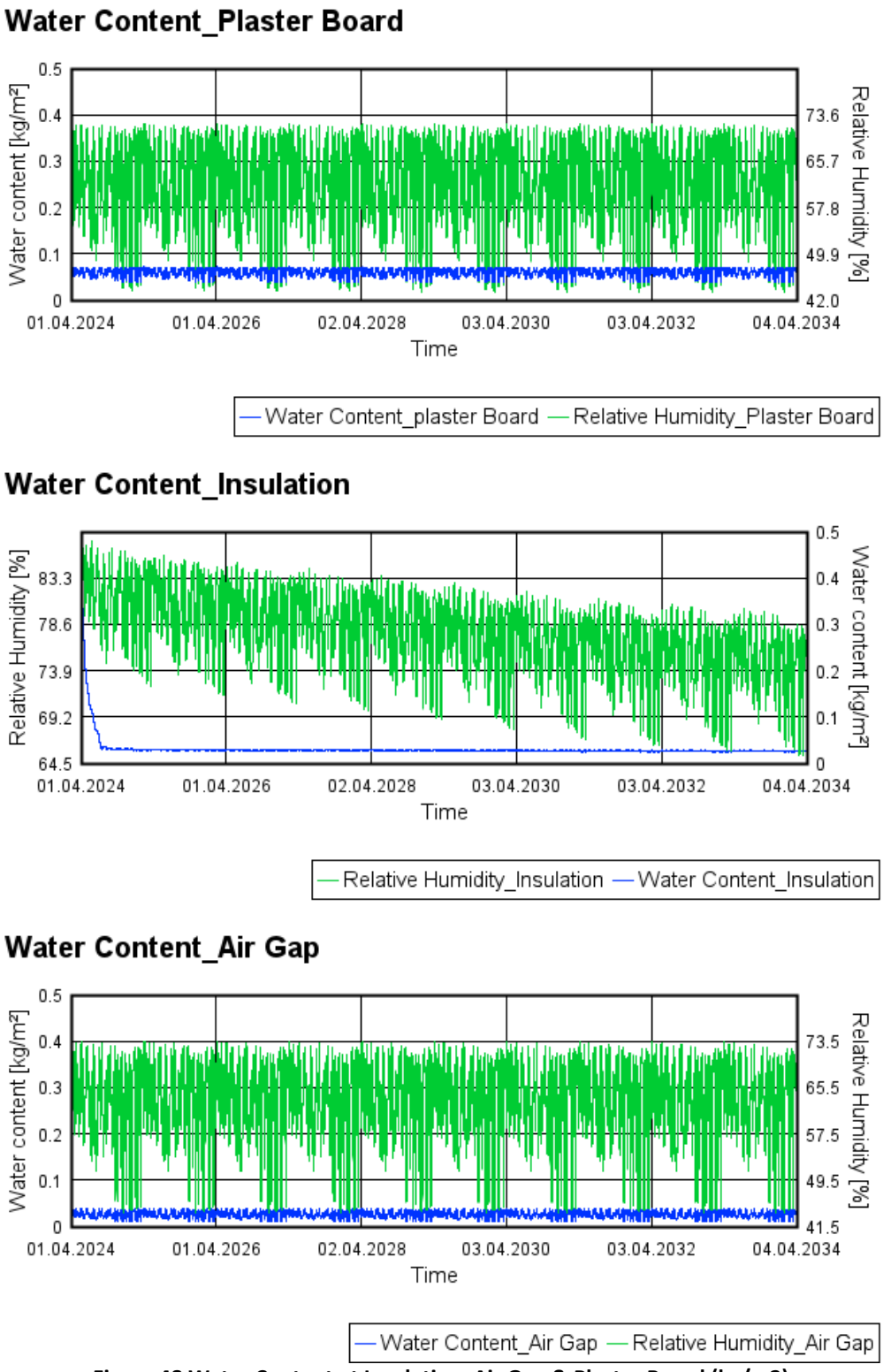


Figure 48 Water Content at Insulation, Air Gap & Plaster Board (kg/m2)

10.4.4 Relative Humidity at Insulation, Air Gap & Plaster

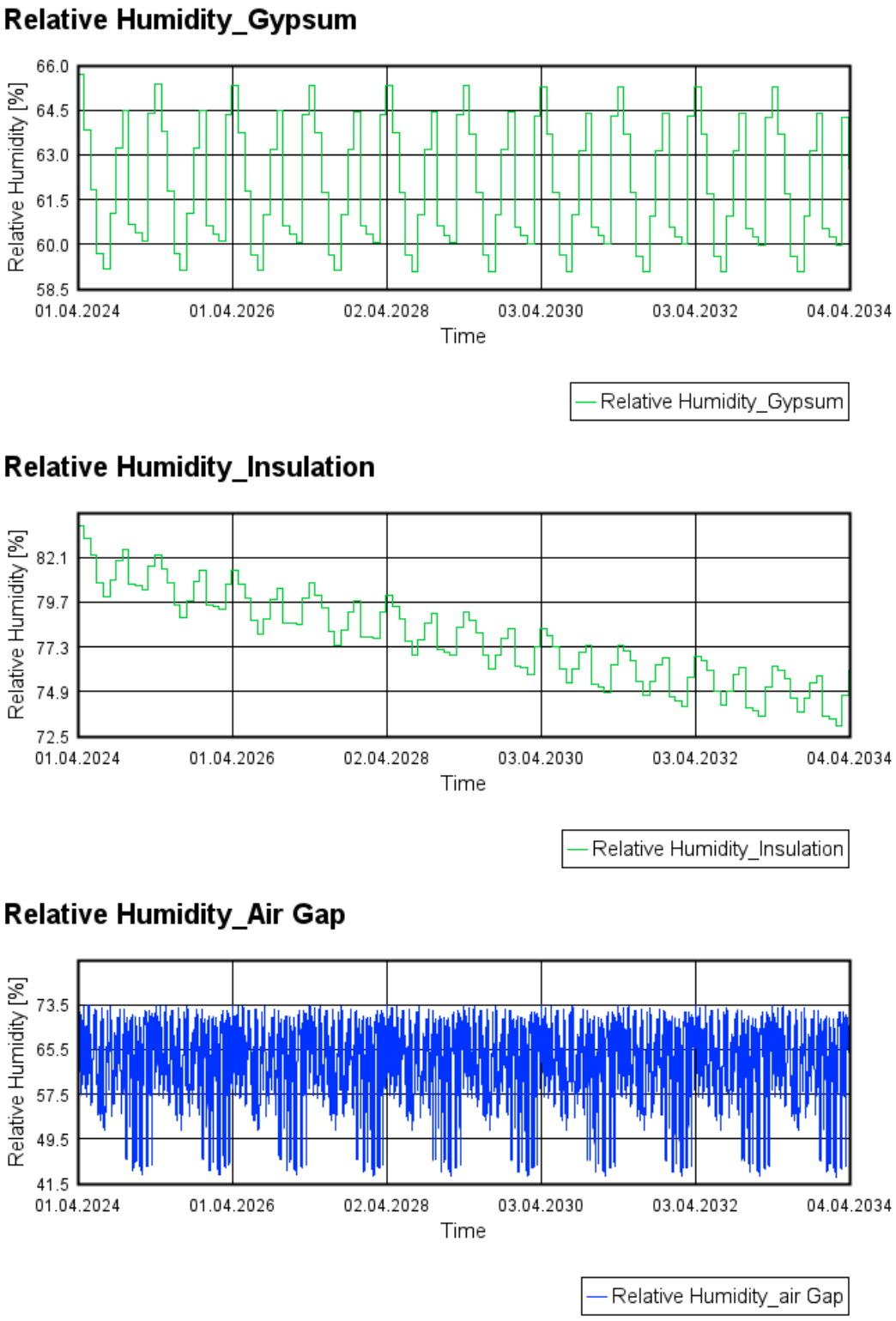


Figure 49 Relative Humidity at Insulation, Air Gap & Plaster

10.4.5 Internal Temperature Vs. Dew point at the Interior Surface

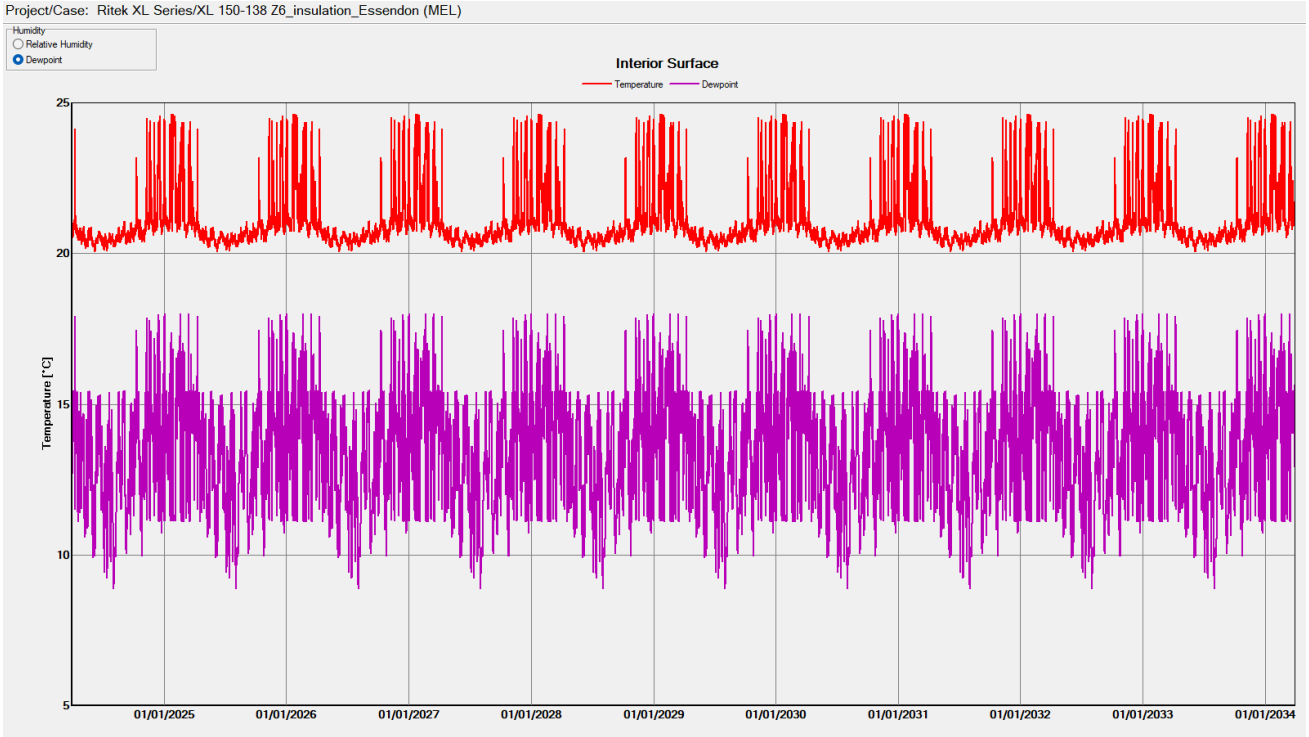


Figure 50 Internal Temperature does not exceed dew point

10.4.6 Summary of Temperature, Water Content and Relative Humidity (Post-Construction)

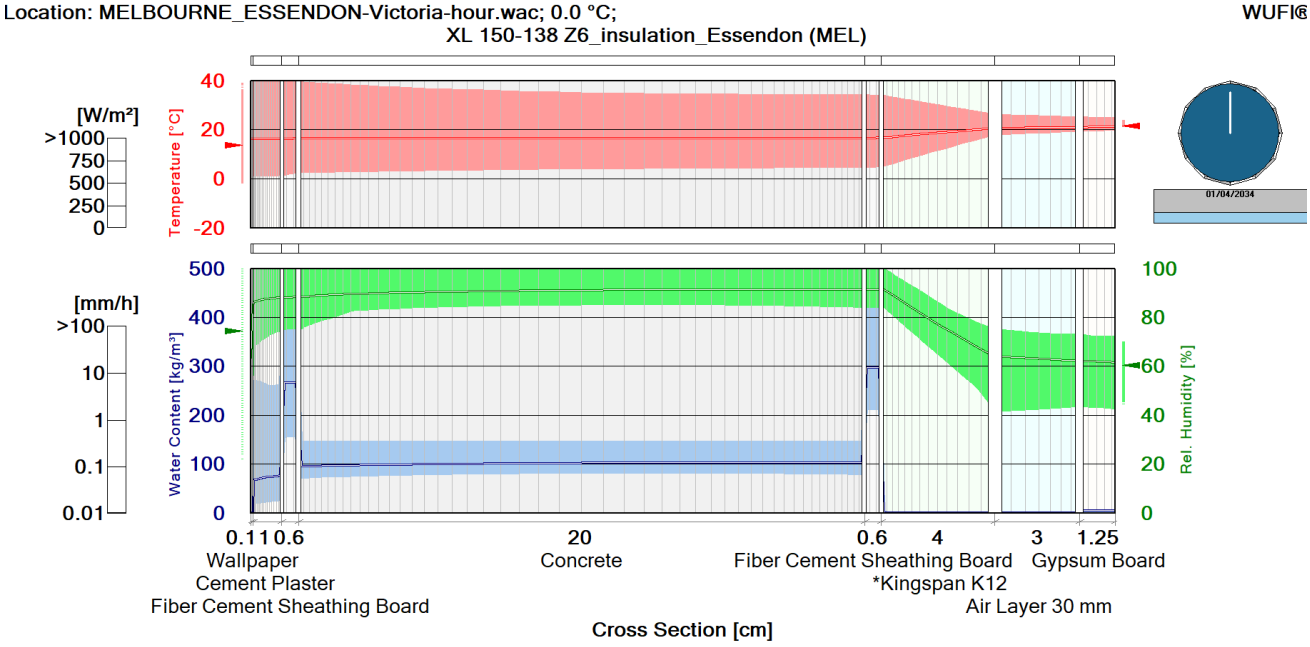


Figure 51 Average of Temperature, Water Content and Relative Humidity (Post-Construction)

10.4.7 Relative humidity (mould growth risk) at the Interior Surface

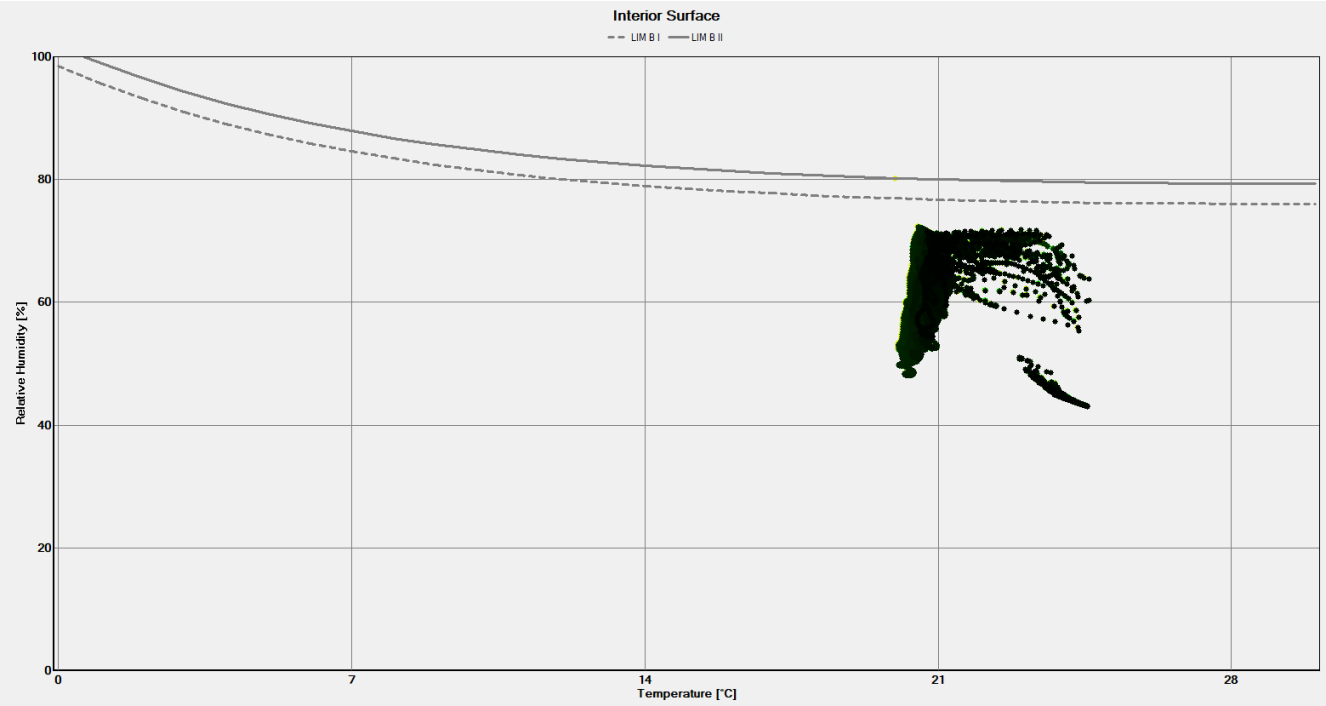


Figure 52 Post Construction <80%. No risk of mould growth at interior face

10.4.8 Mould Growth Risk

10.4.8.1 At Interior Surface

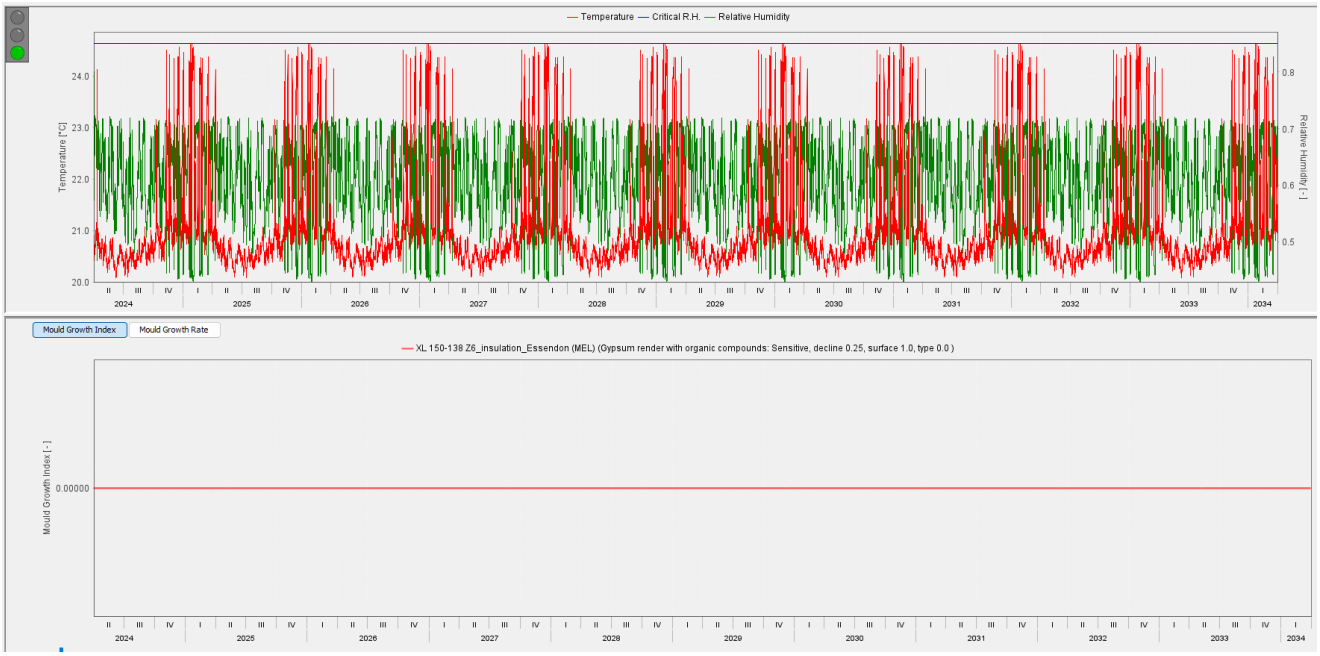


Figure 53 Mould growth Index at interior surface = 0 < 3 thus, OK

10.4.8.2 At air cavity (gypsum face)

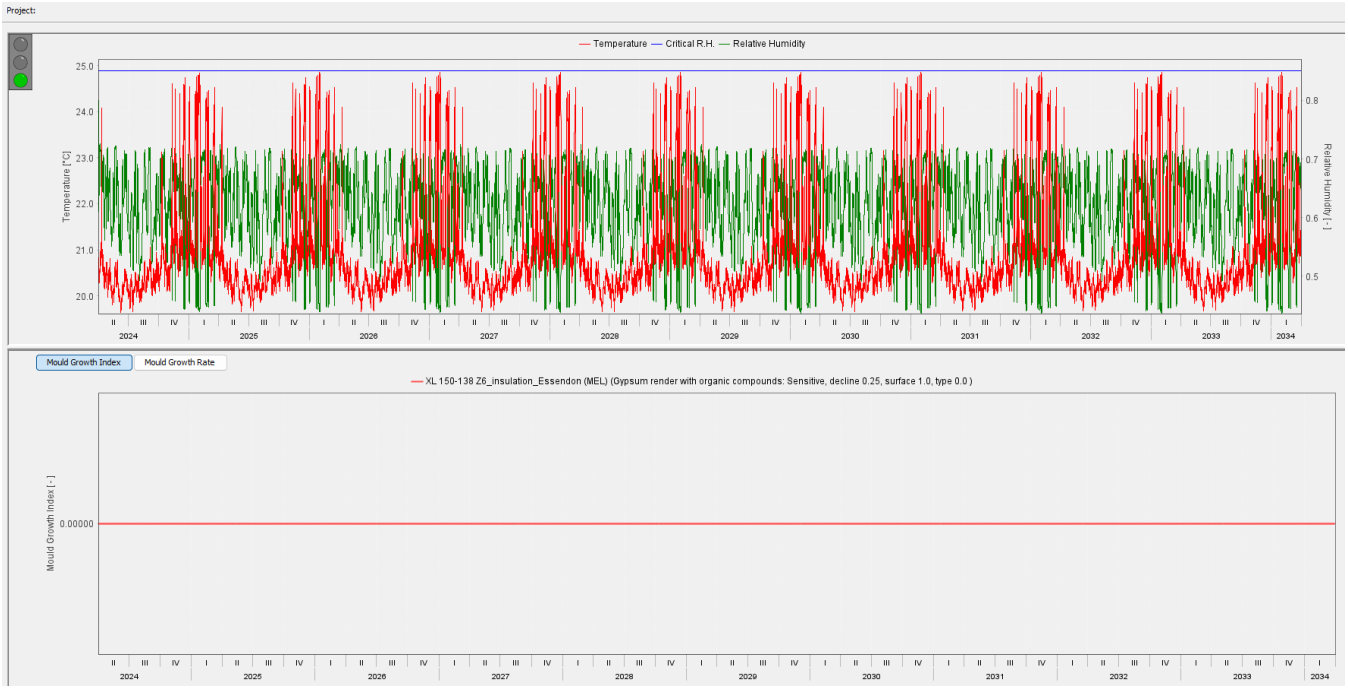


Figure 54 Mould growth Index at air cavity (gypsum face) = 0 < 3 thus, OK

10.4.8.3 At air cavity (Insulation face)

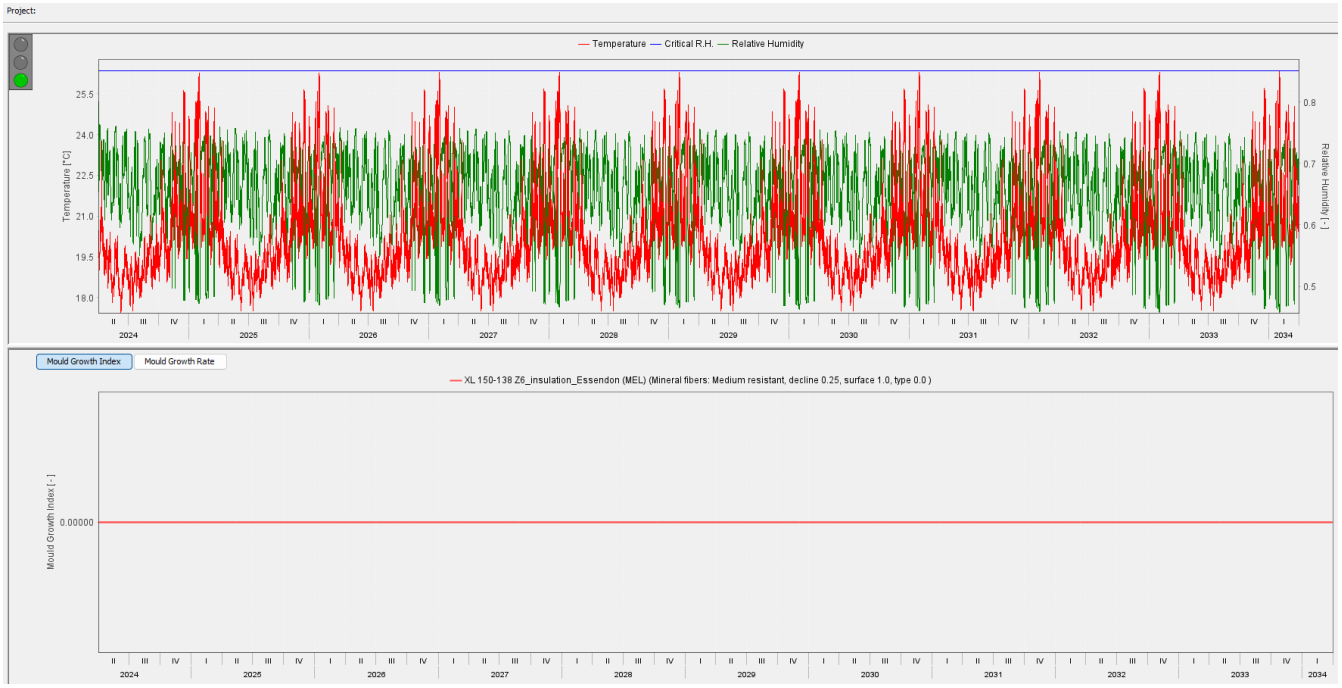


Figure 55 Mould growth Index at air cavity (Insulation face) = 0 < 3 thus, OK

10.4.8.4 At insulation (Ritek Cement Board surface) – During Construction

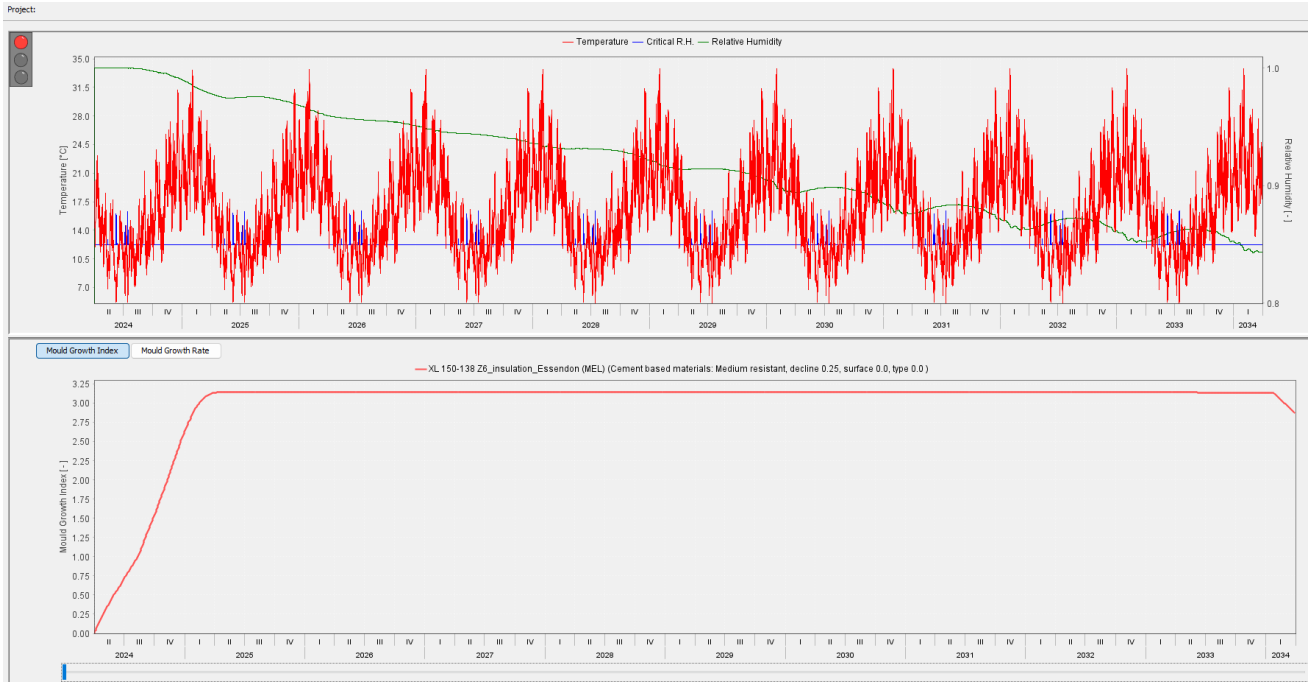


Figure 56 Mould growth Index at insulation surface (Ritek Cement Board surface) – during construction = 3.25 > 3 thus, NOT OK

10.4.8.5 At insulation (Ritek Cement Board surface) – Post Construction

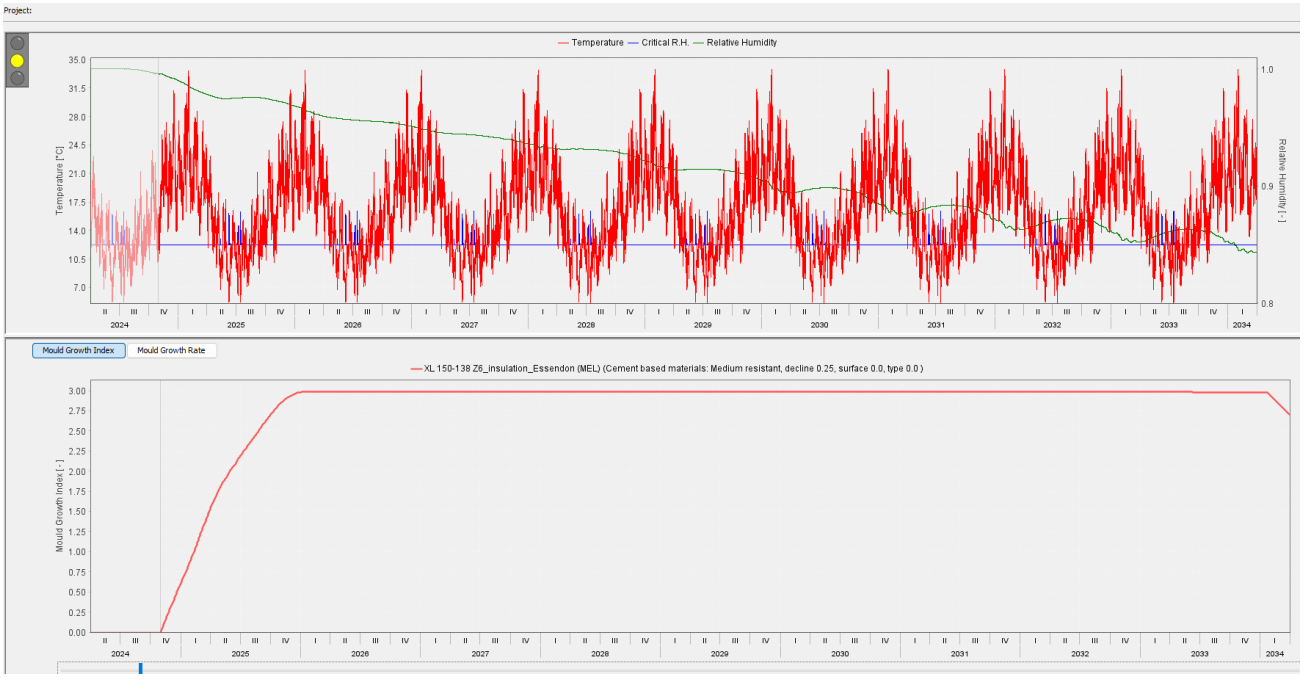


Figure 57 Mould growth Index at insulation surface (Ritek Cement Board surface) – post construction = 2.98 < 3 thus, OK

10.4.9 Key Findings

WUFI analysis Model of 150mm X-PLUS Ritek wall system based on AIRAH DA07 & ASHRAE 160 standards, reveals low moisture levels and mould growth risk for internal elements under worst-case scenario. Key findings are described below:

- The Total Water Content (Cl.10.4.1) of the wall system is at pick during construction and reduces significantly in time. It also, fluctuates slightly with seasonal changes. There is no sign of moisture accumulation in any components of the wall during the 10-year model.
- Moisture levels (RH) within the internal plasterboard (Cl. 10.4.4) lining consistently stay below 65% relative humidity throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the air gap (Cl. 10.4.4) lining consistently stay below 75% relative humidity throughout the 10-years analysis period, which is within acceptable limits.
- Moisture levels (RH) within the insulation layer (Cl. 10.4.4) lining consistently stay below 82% relative humidity at construction phase and reduces slowly throughout the 10-years analysis period, which is within acceptable limits.
- The summary of post construction graph (Cl 10.4.6) shows finding below
    - RH of Inner Fibre Cement Board and Insulation layer exceeds 80% at first but reduces gradually by time.
    - RH never exceed 80% throughout 10 years study in the Air Gap and Plaster Board meaning the risk of condensation is “Low”.
    - Average RH is Approx. 60% for the Air Gap and Plaster Board layers.
    - Average water content is very low for inner layers.
- DIN 4108 limits water content to 500 g/m^2 at interfaces where at least one layer is non-capillary active. The water content in the plaster board ay cavity gap (Cl. 10.4.3) is calculated approx. 90 g/m^2. Thus, the risk of condensate is categorised as “Low”.
- The Mould Growth index (Cl. 10.4.8.4) between Ritek wall and insulation (On Ritek wall fibre cement sheet) is 3.25 at first however, it drops immediately after construction phase and remains below 3 (Cl. 10.4.8.5).
- The Mould Growth index (Cl. 10.4.8) always remain below 3 at internal and air cavity surfaces which satisfy the requirements of NCC 2022, AIRAH DA07 & ASHRAE 160 standards.

11 Key Findings Summary

Our hygrothermal modeling, in accordance with AIRAH DA07 and ASHRAE 160 standards, confirms that the face-sealed 150mm – 200mm Ritek X-PLUS series walls with an external weatherproof render effectively manage condensation risks in Climate Zones 3 & 4 (Wall Type 1) and 5 & 6 (Wall Type 2).

Post-construction, these walls maintain a mould growth factor below 3, complying with the limits established by NCC 2022 and AIRAH DA07, thus ensuring a healthy environment. Key findings include:

- The total water content of all wall types peaks during construction and significantly decreases over time.
- Moisture levels (RH) within the internal plasterboard lining, air gap, and insulation layer did not exceed the established limits for any wall type.
- Water content at interfaces where at least one layer is non-capillary active remained below 150 gr/m^2.
- The Mould Growth Index in the cavity area for Wall Type 1 (Climate Zones 2 & 3) consistently stayed below 3.
- For Wall Type 2 (Climate Zones 5 & 6), the maximum Mould Growth Index between the Ritek wall and insulation (on Ritek wall fiber cement sheet) was calculated at 3.25 during construction, but it quickly drops post-construction and remains below 3. It is important to note that this is not a concern as the model does not account for the sequencing of construction events. For example, when the concrete is poured (maximum moisture content), the insulation layer is not yet in place, thus the Mould Growth Index during this phase can be disregarded.
- The Mould Growth Index Stayed below 3 at internal surface for all wall types.

The key findings are presented in Table 3.

Table 3 Key Findings Summary

Wall Type	Climate Zone	Location	Increase in Total Water Content?	RH at internal surface exceed limits?	RH at cavity exceed limits?	Max. Mould Growth Index (During Construction)	Max. Mould Growth Index (Post-Construction)	Risk Level
1	2	Brisbane, QLD	NO	NO	NO	2.5	1.7	LOW
1	3	Charleville, QLD	NO	NO	NO	0.32	0	LOW
2	4	SYD – Airport, NSW	NO	NO	NO	3.25*	2.9	LOW
2	5	MEL – Essendon, VIC	NO	NO	NO	3.25*	2.9	LOW

* Can be disregarded as the model does not account for the sequencing of construction events

As a result of the above, it can be concluded that the risks associated with condensation and mould growth have been effectively managed to minimise their impact on the health of occupants.

Yours faithfully,

Kevin Zia,
Prime Consulting Engineers
MEng, MIEAust, CPEng, NER, APEC, IntPE (Aus), RPEQ

12 Appendix A

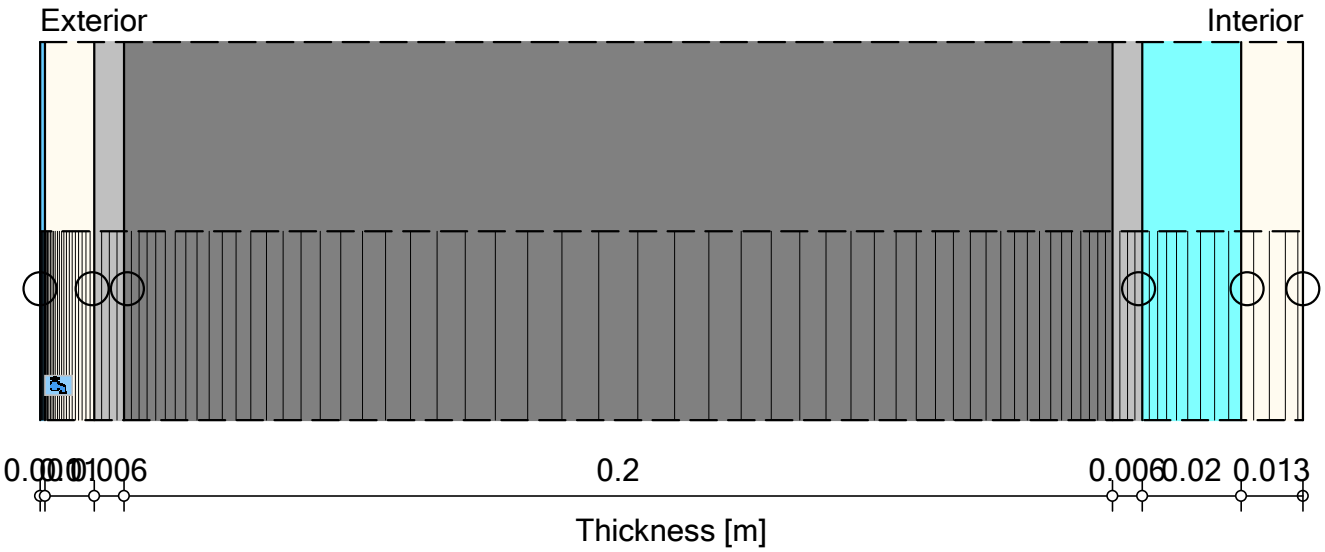
WUFI PRO reports

Project Data

Project Name	Ritek XL Series
Project Number	24-810
Client	Ritek Australia
Contact Person	Kevin Zia
City/Zip	
Street	
Phone	
Fax	
e-mail	
Responsible	
Remarks	
Date	18/04/2024

Component Assembly

Case: XL150-138 Z2_Brisbane



- Monitor positions

/ - Heat/Moisture source/sink positions

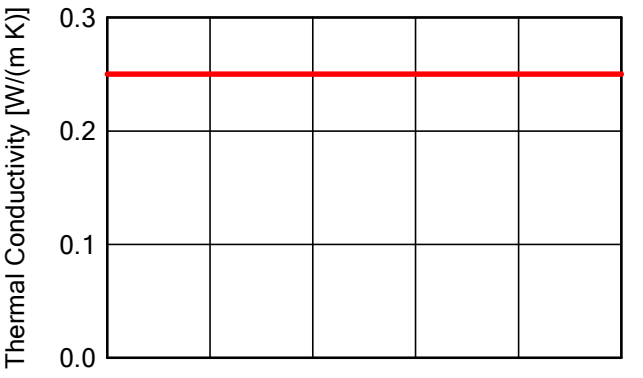
Materials:

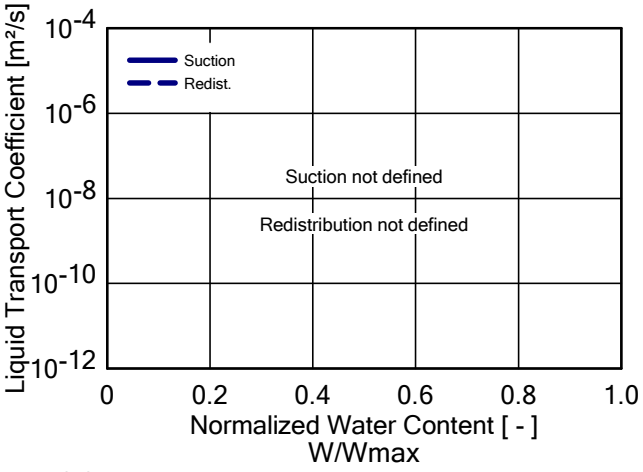
	- Wallpaper, acrylic	0.001 m
	- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
	- Fiber Cement Sheathing Board	0.006 m
	- Concrete, C35/45	0.2 m
	- Fiber Cement Sheathing Board	0.006 m
	- Air Layer 20 mm	0.02 m
	- Gypsum Board	0.013 m

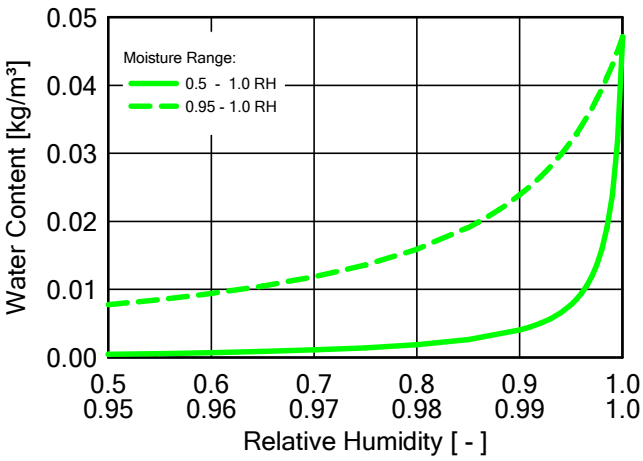
Total Thickness: 0.256 m
R-Value: 0.37 (m² K)/W
U-Value: 1.801 W/(m² K)

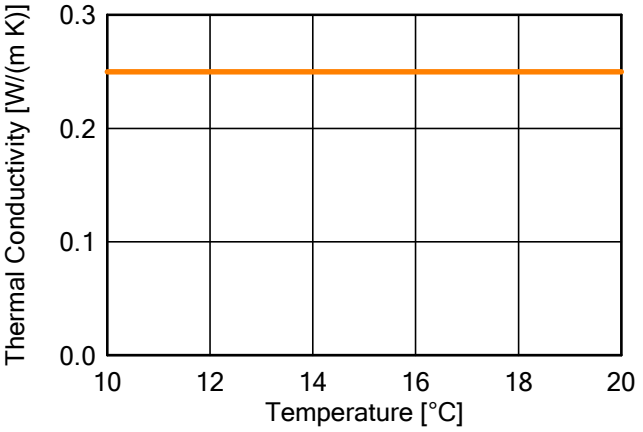
Material: Wallpaper, acrylic

Property	Unit	Value
Bulk density	[kg/m³]	930
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/(kg K)]	1260
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.25
Water Vapour Diffusion Resistance Factor	[-]	2100



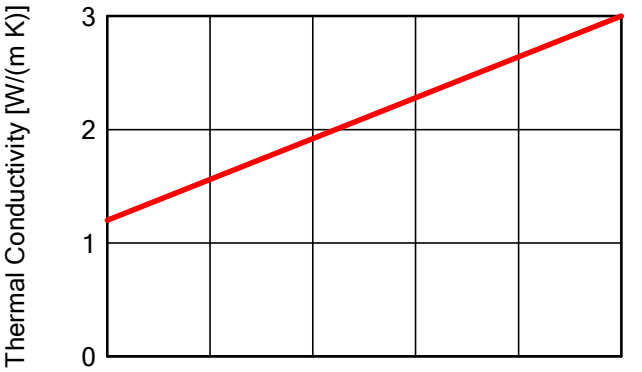


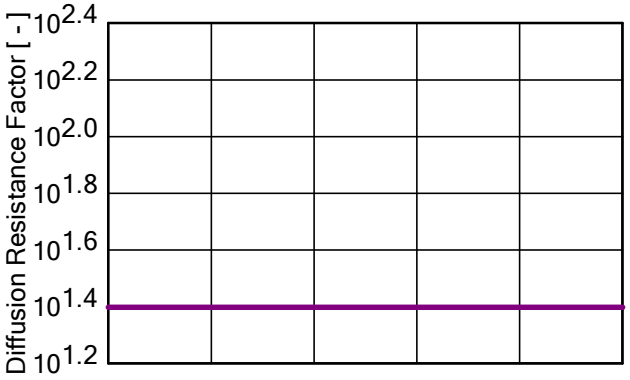


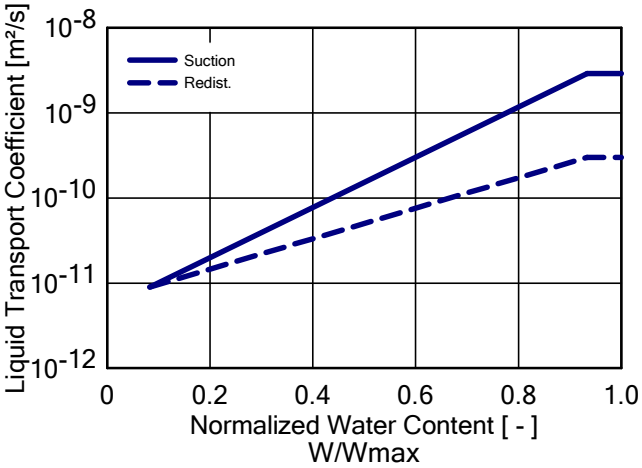


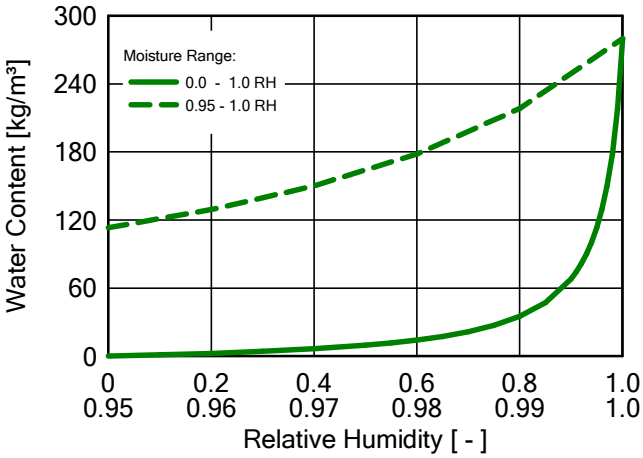
Material: Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

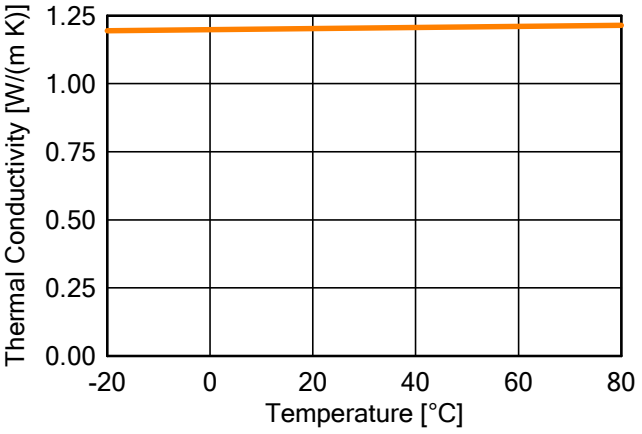
Property	Unit	Value
Bulk density	[kg/m³]	2000
Porosity	[m³/m³]	0.3
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.2
Water Vapour Diffusion Resistance Factor	[-]	25
Reference Water Content	[kg/m³]	35
Free Water Saturation	[kg/m³]	280
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	10
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





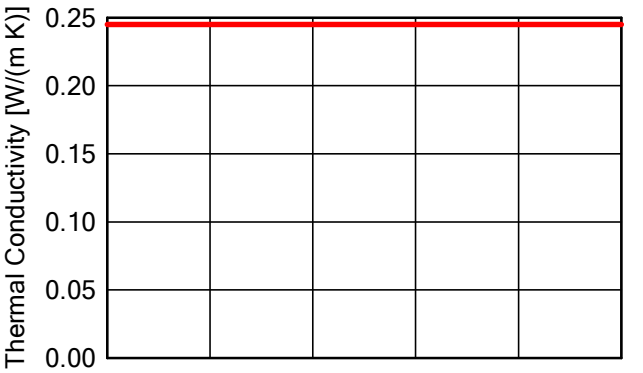


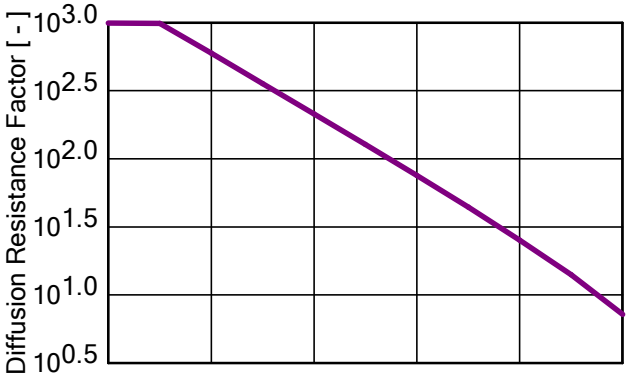


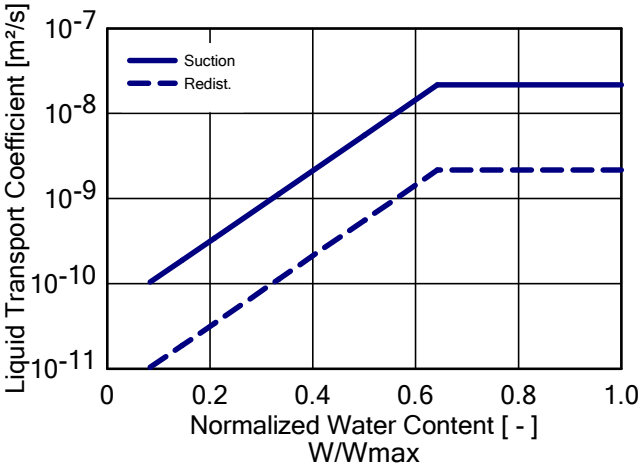


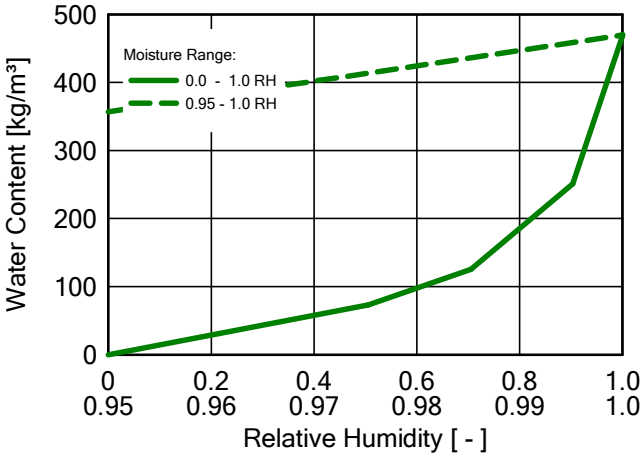
Material: Fiber Cement Sheathing Board

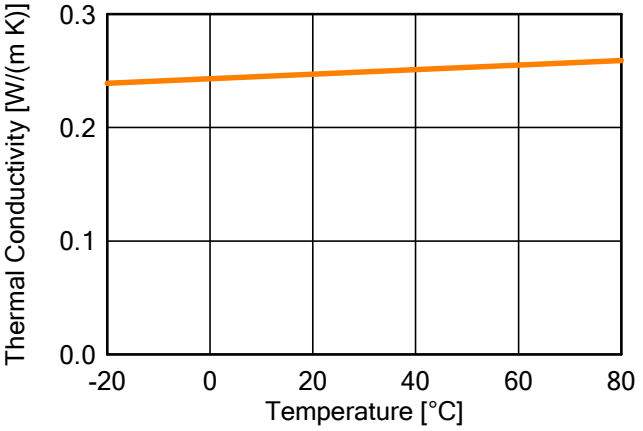
Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





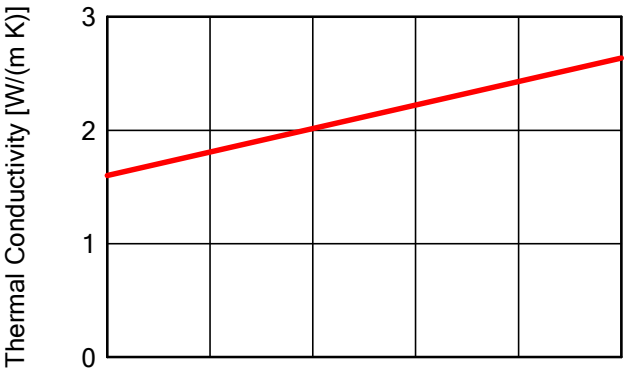


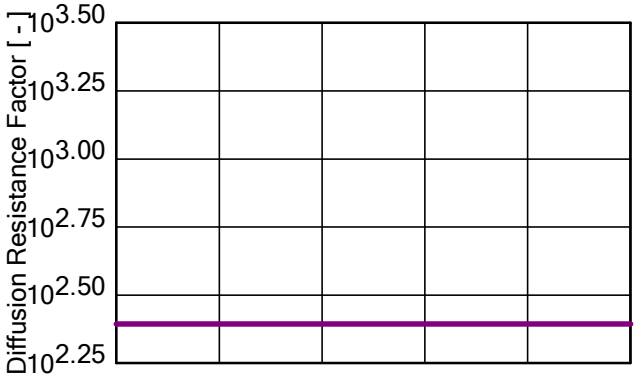


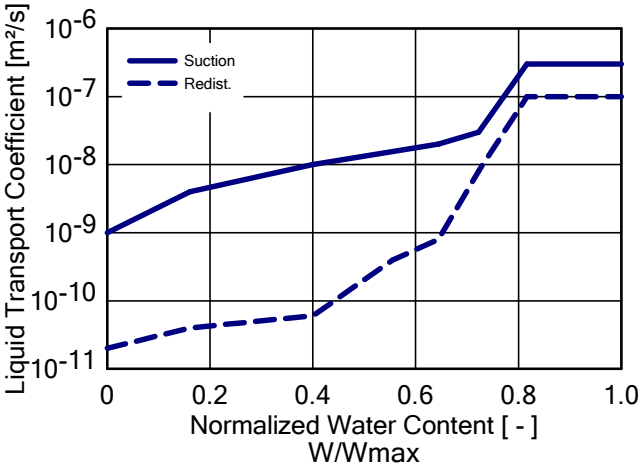


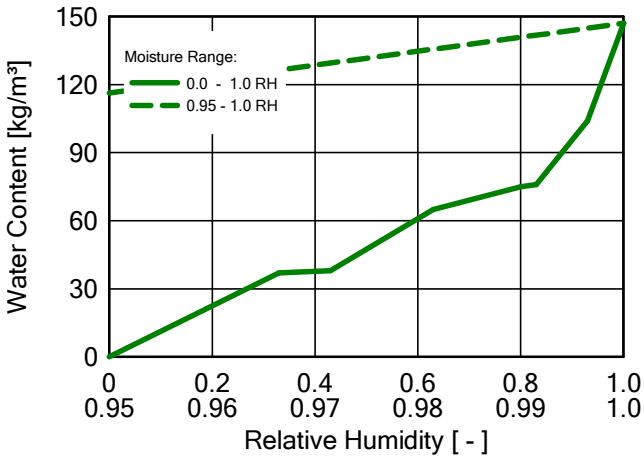
Material: Concrete, C35/45

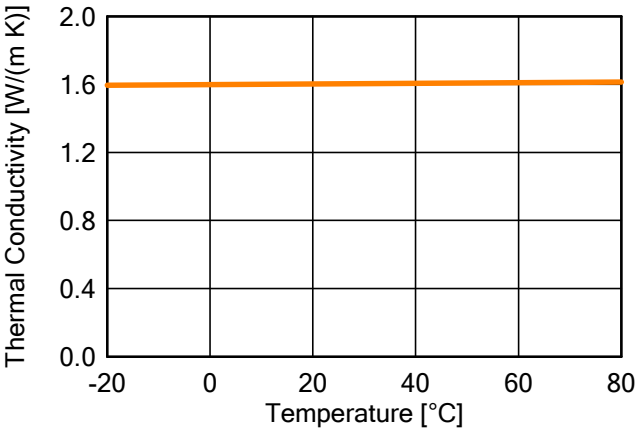
Property	Unit	Value
Bulk density	[kg/m³]	2220
Porosity	[m³/m³]	0.18
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.6
Water Vapour Diffusion Resistance Factor	[-]	248
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





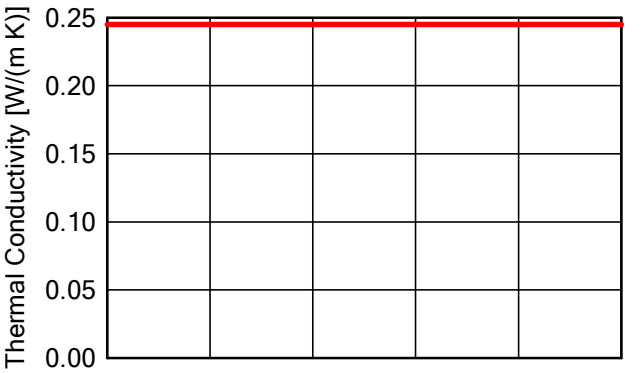


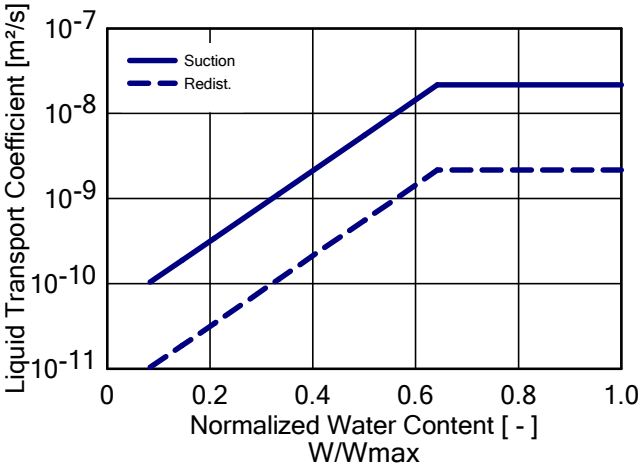


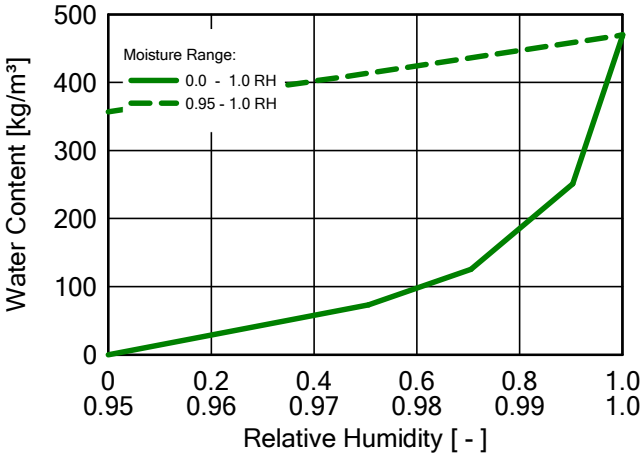


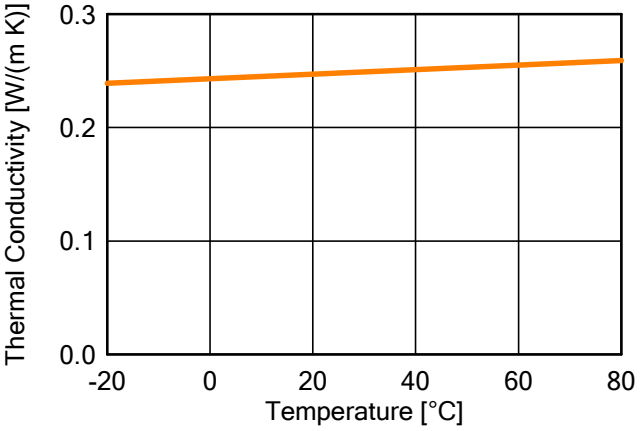
Material: Fiber Cement Sheathing Board

Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4



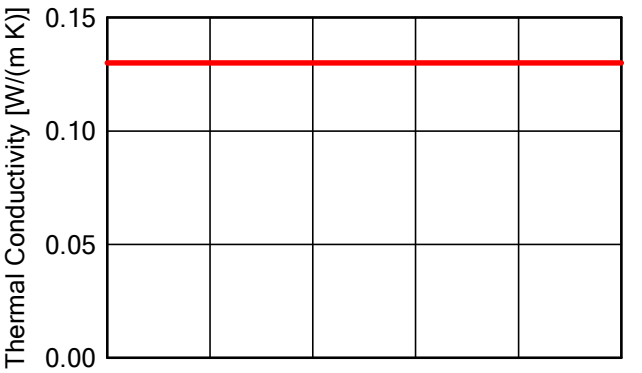


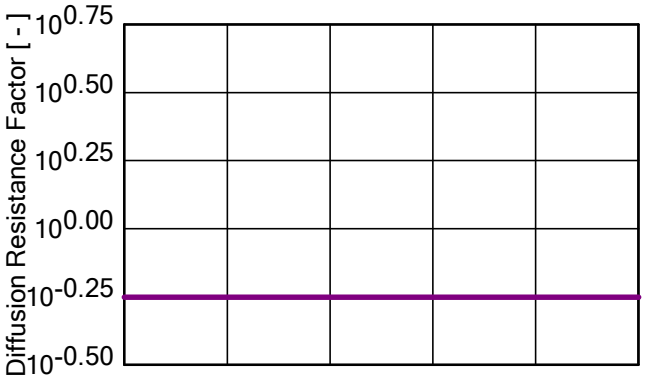


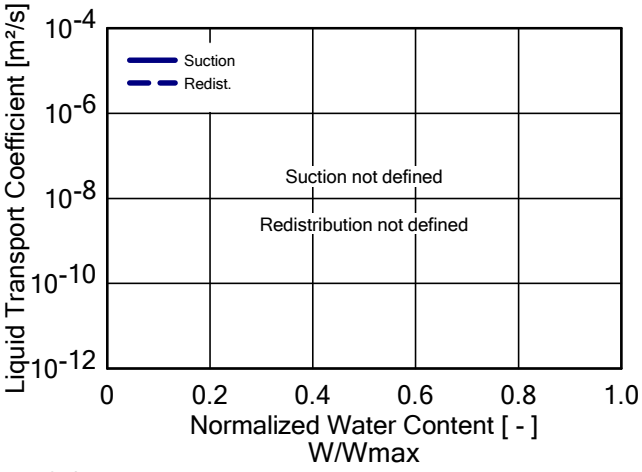


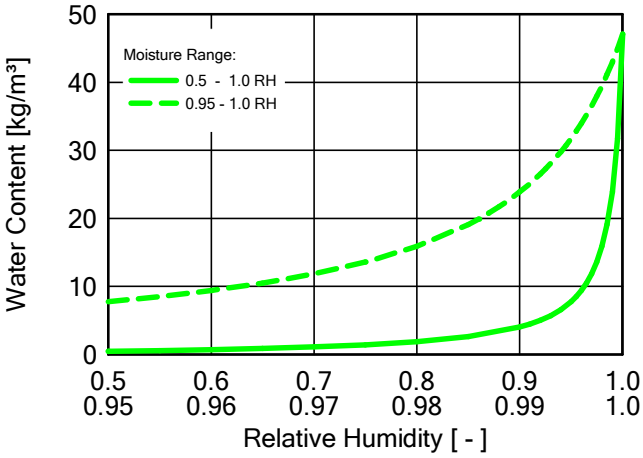
Material: Air Layer 20 mm

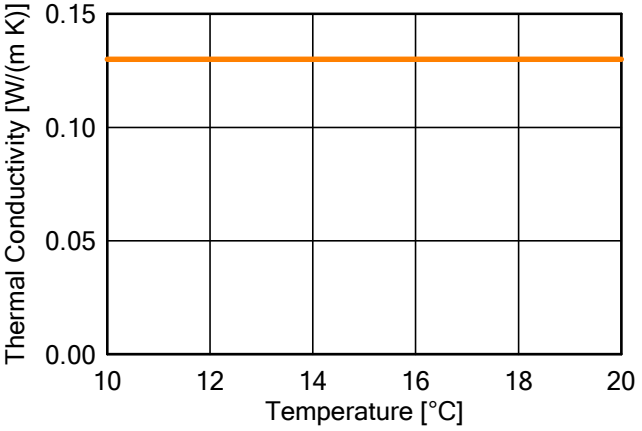
Property	Unit	Value
Bulk density	[kg/m³]	1.3
Porosity	[m³/m³]	0.999
Specific Heat Capacity, Dry	[J/(kg K)]	1000
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.13
Water Vapour Diffusion Resistance Factor	[-]	0.56





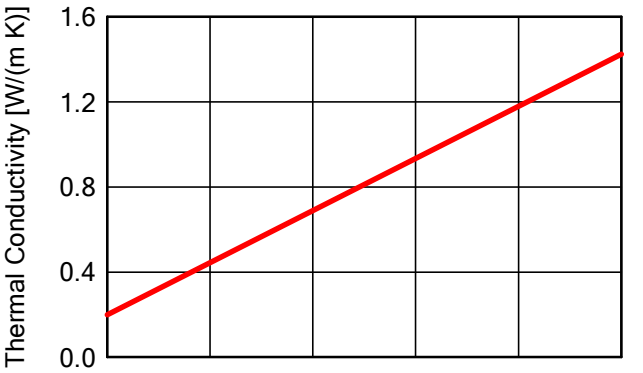


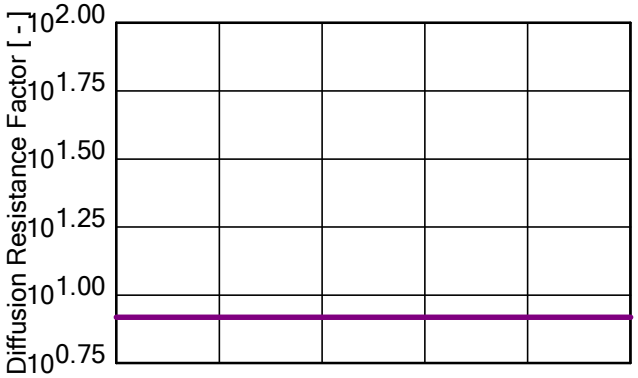


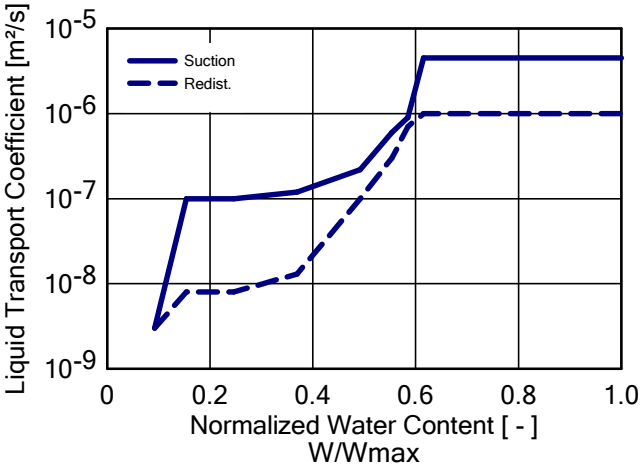


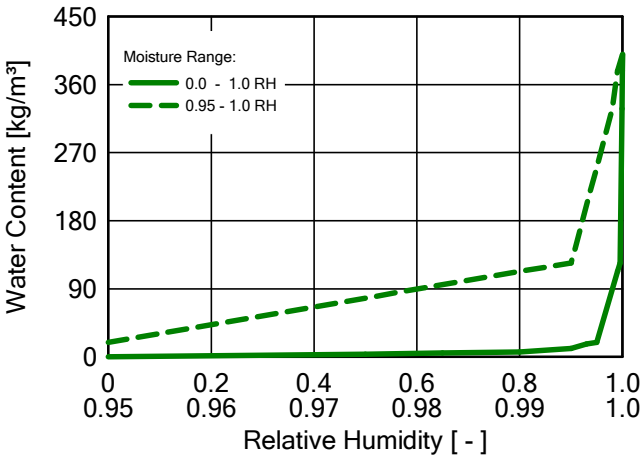
Material: Gypsum Board

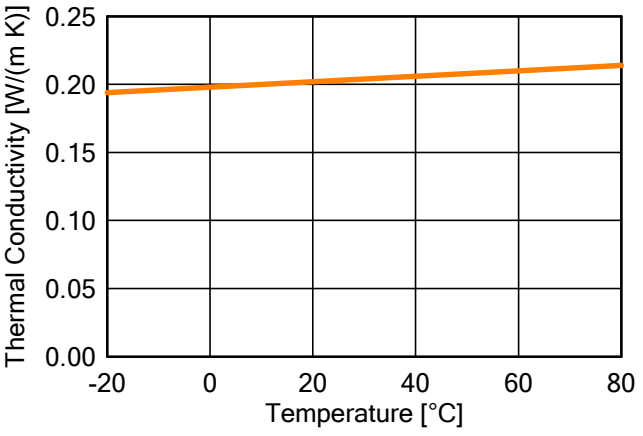
Property	Unit	Value
Bulk density	[kg/m³]	850
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4











Boundary Conditions

Exterior (Left Side)

Location:	Brisbane-Queensland-hour.wac
Temperature Shift:	0.0 °C
Orientation / Inclination:	East / 90 °

Interior (Right Side)

Indoor Climate:	ASHRAE 160P Air-conditioning; 2,8 °C; 21,1 °C; 23,9 °C M.Rate 1.05E-4 kg/s; A.Ch.Rate 0.2 1/h; Vol. 500 m³ Humidity Ratio Wo -1.0000 kg/kg

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Transfer Coefficient - includes long-wave radiation	External Wall	[W/(m² K)]	17 yes
sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	white, bright hue (DIN 410	[-]	0.4
Long-Wave Radiation Emissivity	white, bright hue (DIN 410	[-]	----
Adhering Fraction of Rain	Depending on inclination o	[-]	0.7
Explicit Radiation Balance			no

Interior (Right Side)

Name	Description	Unit	Value
Heat Transfer Coefficient	External Wall	[W/(m² K)]	8
sd-Value	No coating	[m]	----

Sources, Sinks

Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

Name	Type		
Source1	*Moisture Source; Fraction of Rain Load*		
	Start Depth in Layer	[m]	0
	End Depth in Layer	[m]	.005
	Cut-Off at Free Water Saturation	[kg/m³]	280
	ANSI/ASHRAE standard 160	[%]	1

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	01/05/2024 2:10:40 pm
Computing Time	1 min,43 sec.
Begin / End of calculation	01/04/2024 / 01/04/2034
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -52.45
Integral of fluxes, right side (kr,dr)	[kg/m²]	0.0 19.21
Balance 1	[kg/m²]	-23.46
Balance 2	[kg/m²]	-23.47

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	39.03	15.56	15.47	39.03

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
Wallpaper, acrylic	0.00	0.00	0.00	0.02
Cement Plaster (stucco, A-value: 0.5	70.00	40.16	22.20	264.38
Fiber Cement Sheathing Board	185.83	196.05	143.09	469.06
Concrete, C35/45	179.90	67.49	67.49	179.90
Fiber Cement Sheathing Board	185.83	71.49	66.87	471.37
Air Layer 20 mm	1.88	0.48	0.39	18.09
Gypsum Board	6.30	3.69	3.41	9.61

Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-15325.45
Heat Flux, right side	[MJ/m²]	217.81
Moisture Fluxes, left side	[kg/m²]	-52.45
Moisture Fluxes, right side	[kg/m²]	19.21

Hygrothermal Sources

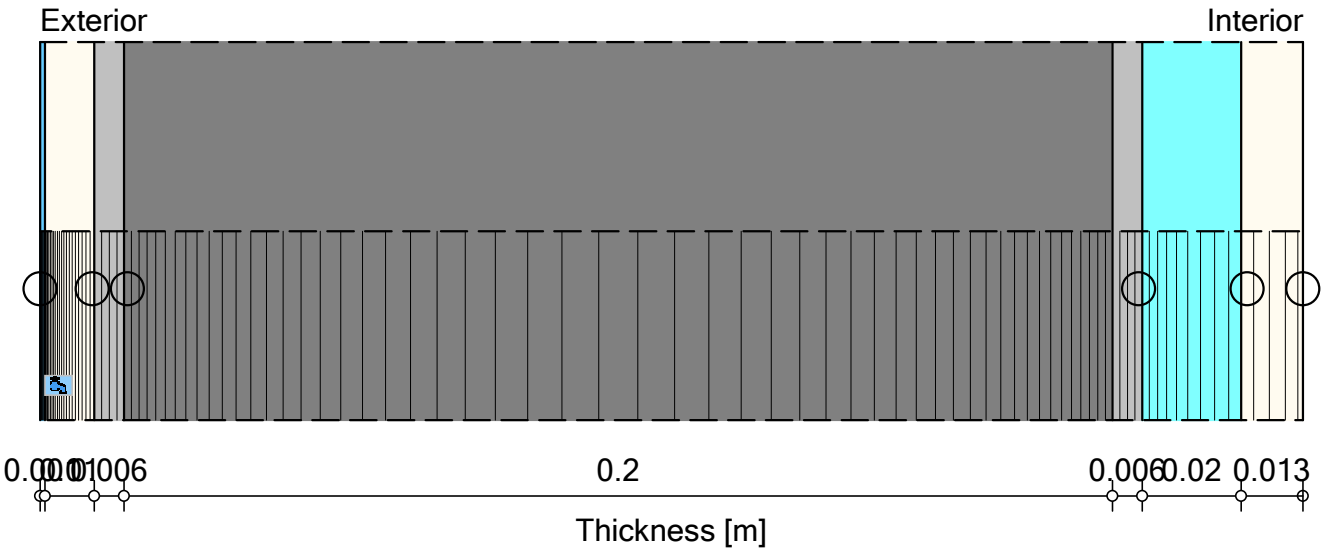
Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	48.203
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Source1 (Moisture Source)	[kg/m²]	48.203

Project Data

Project Name	Ritek XL Series
Project Number	24-810
Client	Ritek Australia
Contact Person	Kevin Zia
City/Zip	
Street	
Phone	
Fax	
e-mail	
Responsible	
Remarks	
Date	18/04/2024

Component Assembly

Case: XL150-138 Z3_Charleville



- Monitor positions

- Heat/Moisture source/sink positions

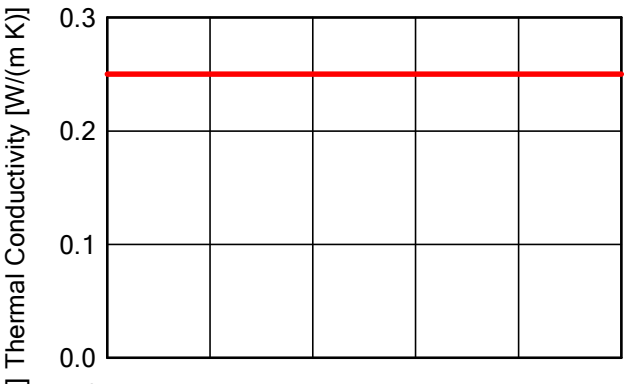
Materials:

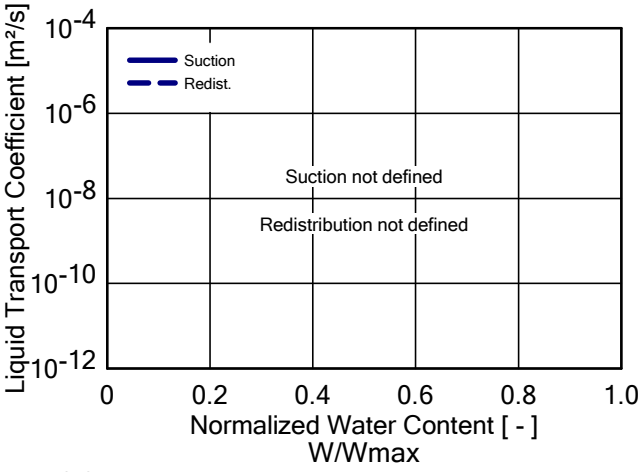
	- Wallpaper, acrylic	0.001 m
	- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
	- Fiber Cement Sheathing Board	0.006 m
	- Concrete, C35/45	0.2 m
	- Fiber Cement Sheathing Board	0.006 m
	- Air Layer 20 mm	0.02 m
	- Gypsum Board	0.013 m

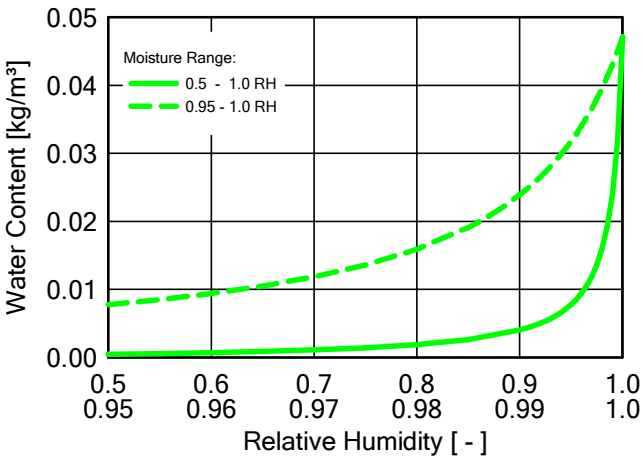
Total Thickness: 0.256 m
R-Value: 0.37 (m² K)/W
U-Value: 1.801 W/(m² K)

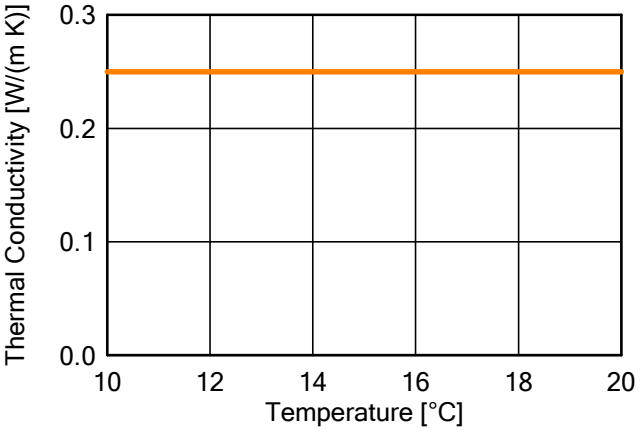
Material: Wallpaper, acrylic

Property	Unit	Value
Bulk density	[kg/m³]	930
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/(kg K)]	1260
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.25
Water Vapour Diffusion Resistance Factor	[-]	2100



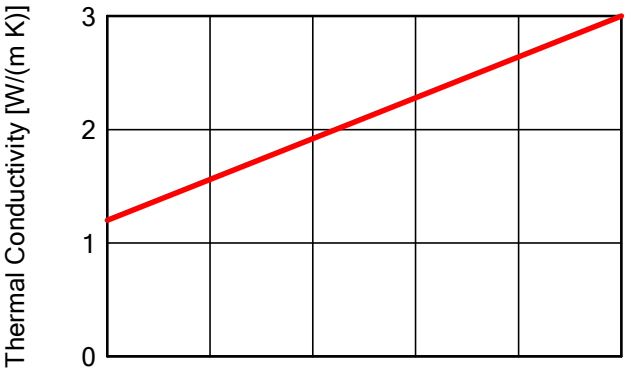


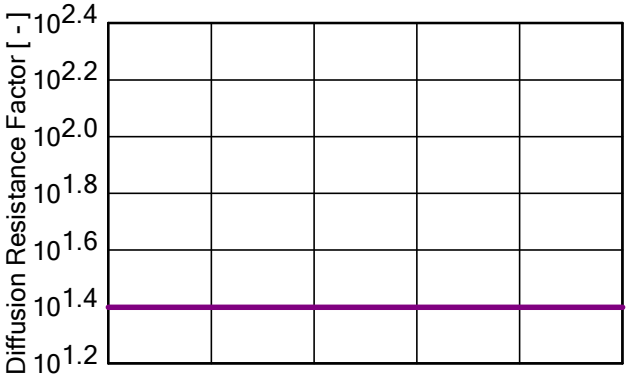


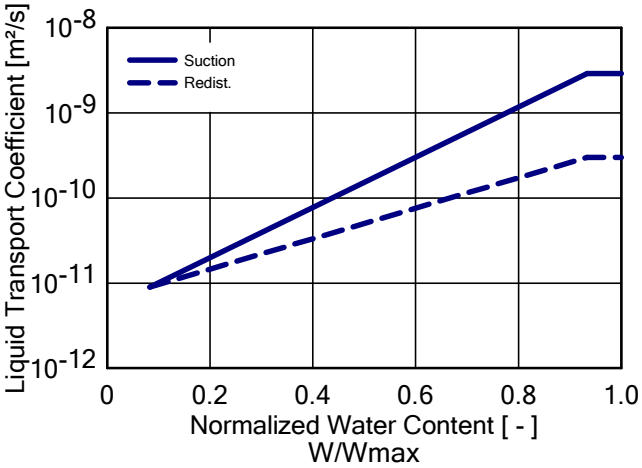


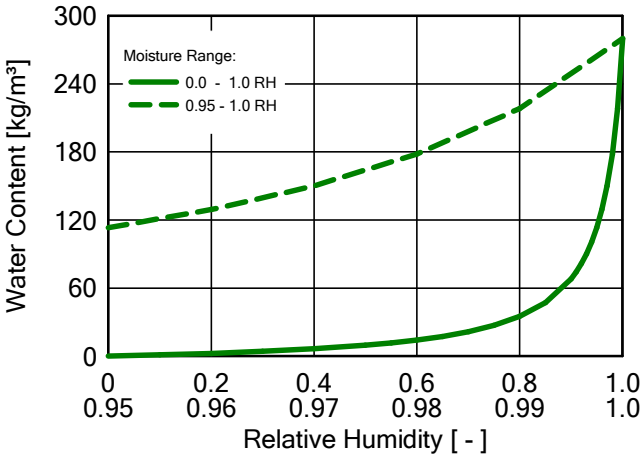
Material: Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

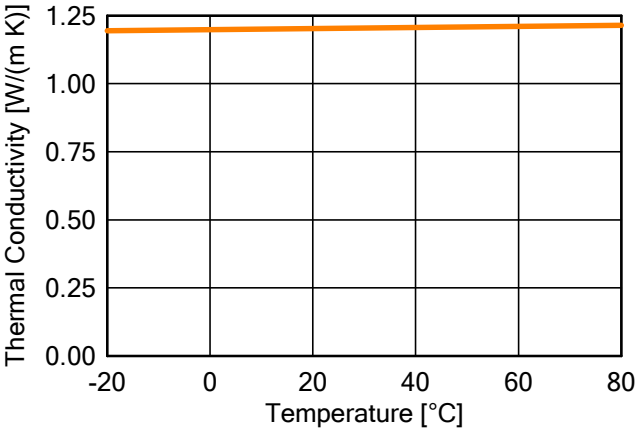
Property	Unit	Value
Bulk density	[kg/m³]	2000
Porosity	[m³/m³]	0.3
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.2
Water Vapour Diffusion Resistance Factor	[-]	25
Reference Water Content	[kg/m³]	35
Free Water Saturation	[kg/m³]	280
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	10
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





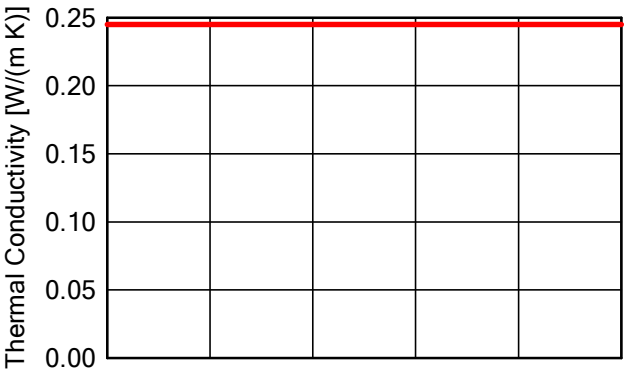


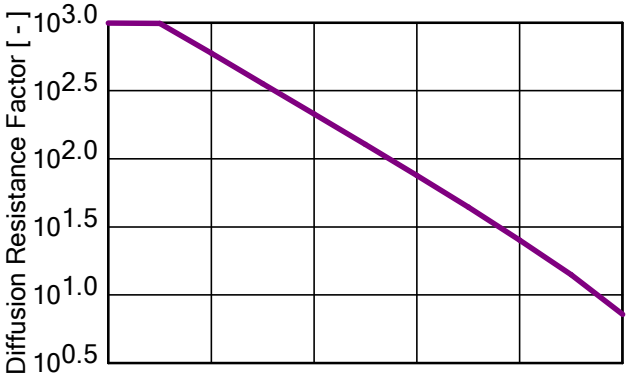


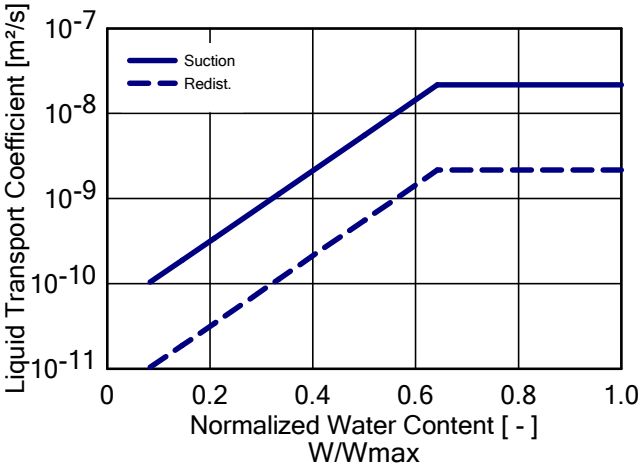


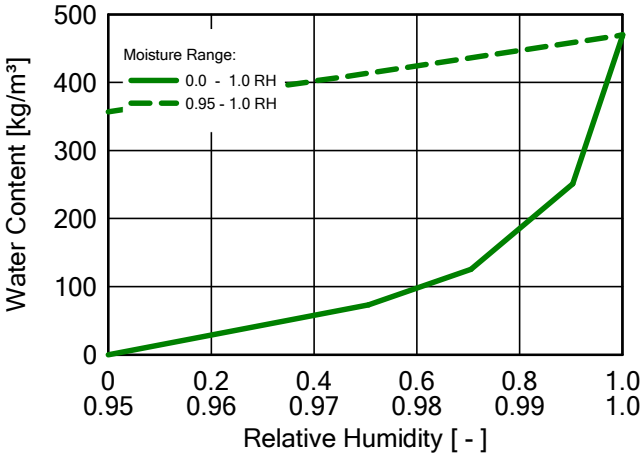
Material: Fiber Cement Sheathing Board

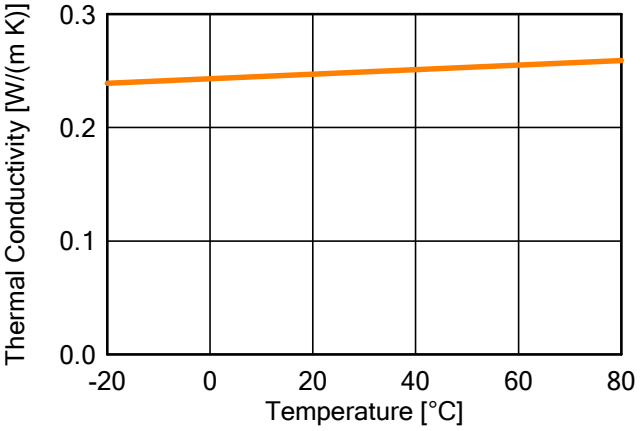
Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





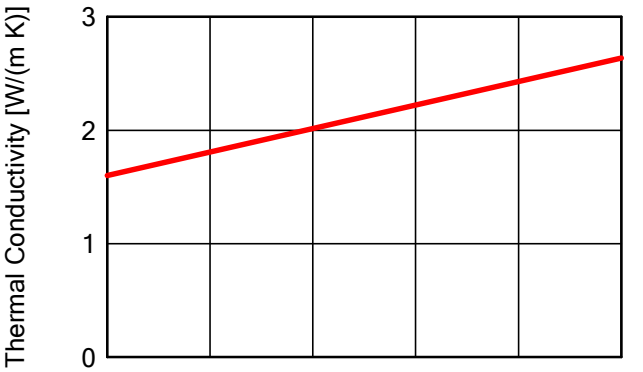


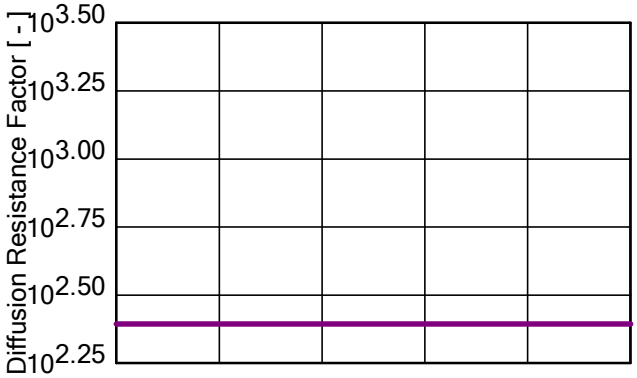


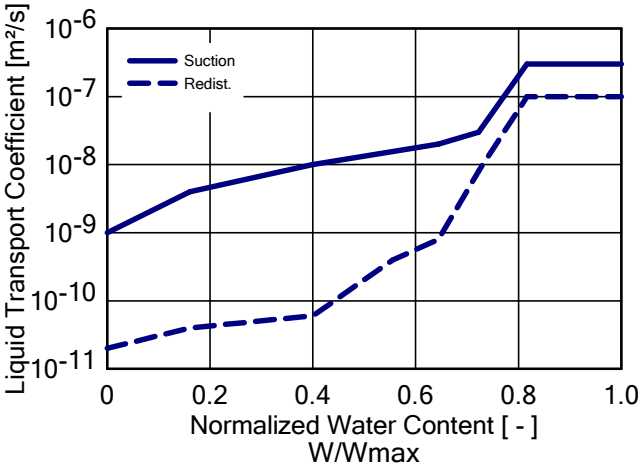


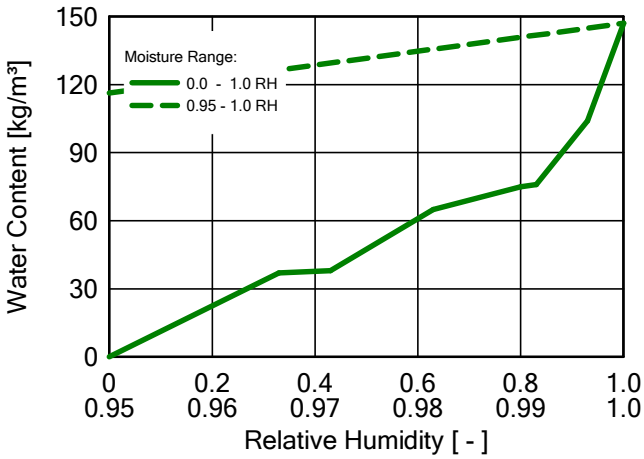
Material: Concrete, C35/45

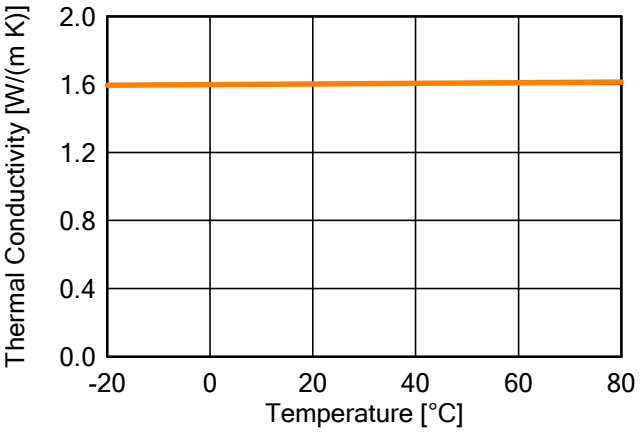
Property	Unit	Value
Bulk density	[kg/m³]	2220
Porosity	[m³/m³]	0.18
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.6
Water Vapour Diffusion Resistance Factor	[-]	248
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





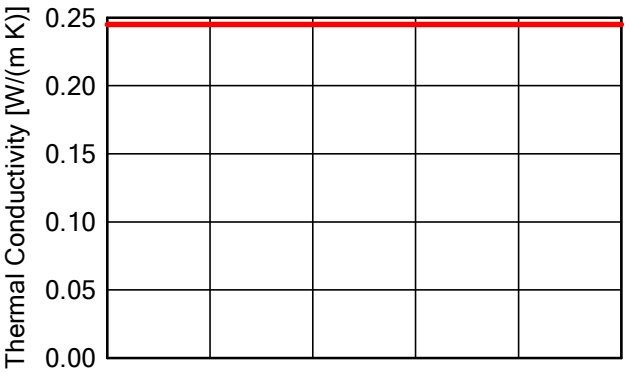


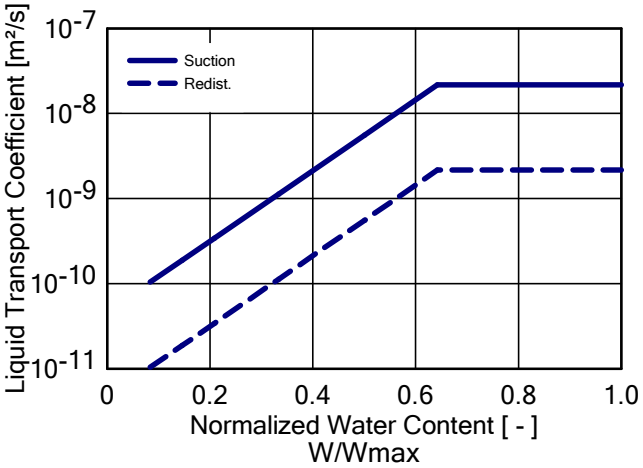


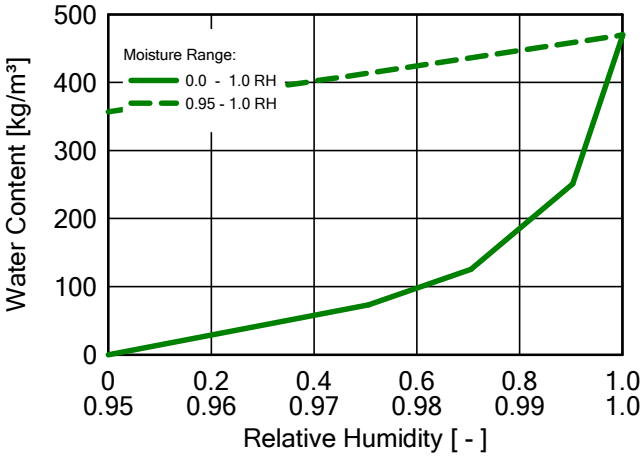


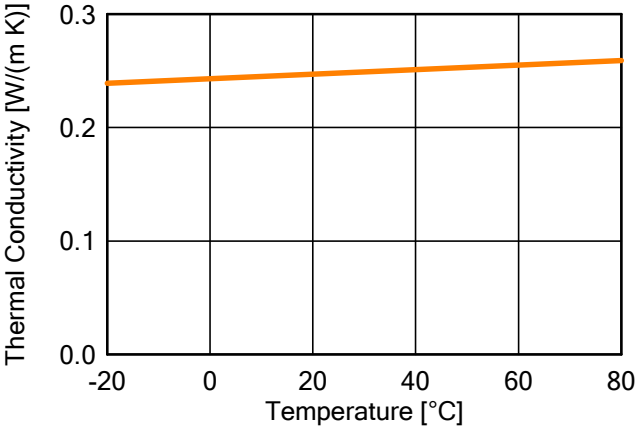
Material: Fiber Cement Sheathing Board

Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4



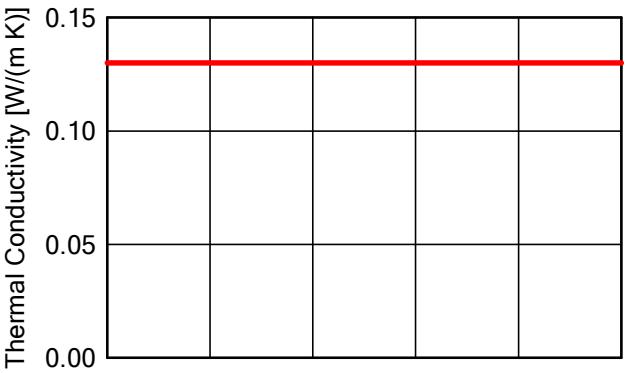


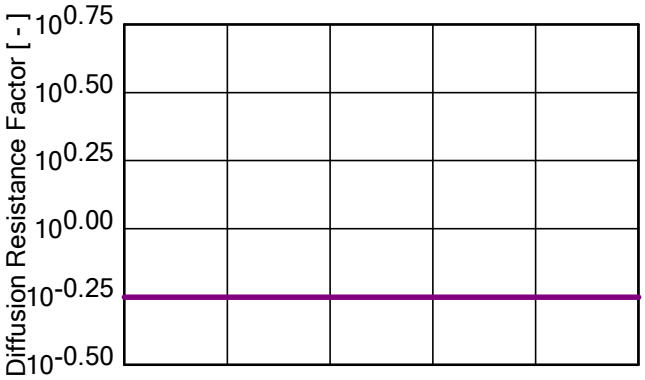


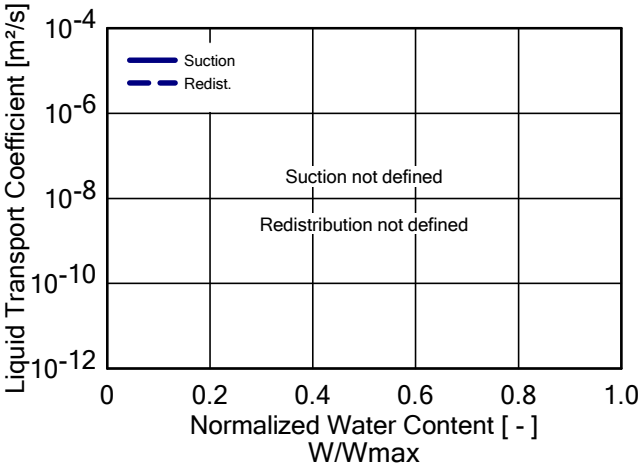


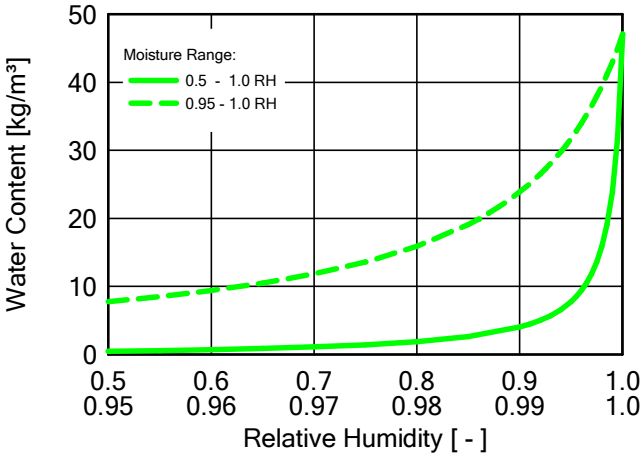
Material: Air Layer 20 mm

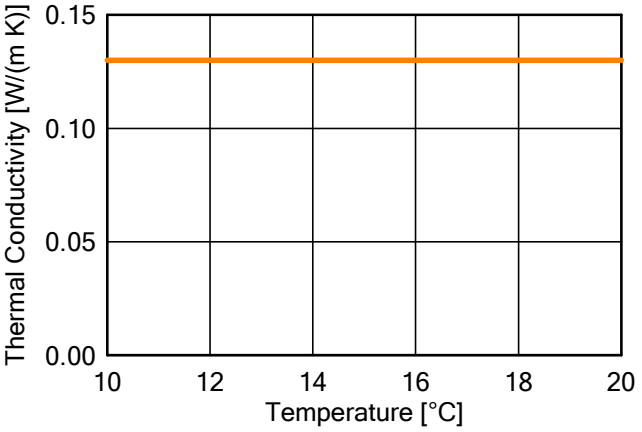
Property	Unit	Value
Bulk density	[kg/m³]	1.3
Porosity	[m³/m³]	0.999
Specific Heat Capacity, Dry	[J/(kg K)]	1000
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.13
Water Vapour Diffusion Resistance Factor	[-]	0.56





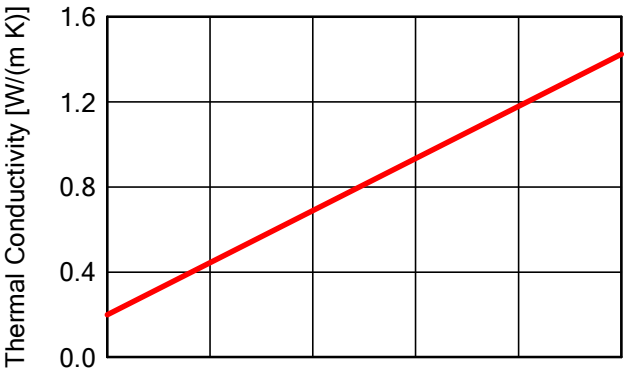


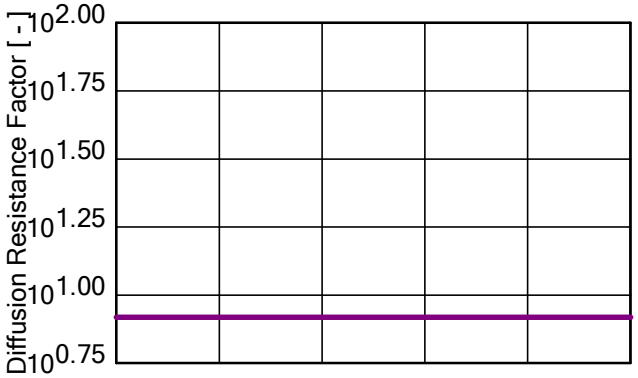


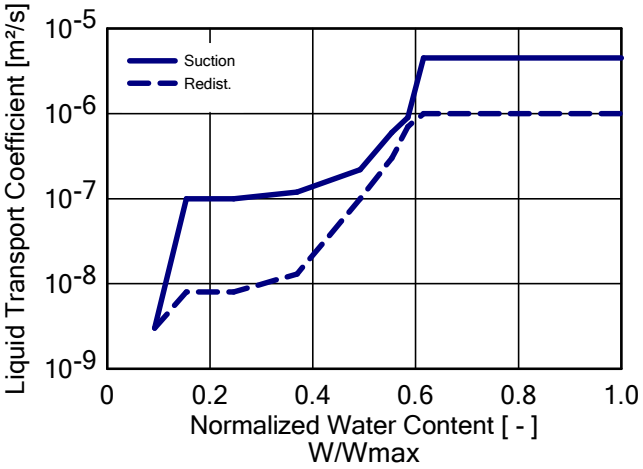


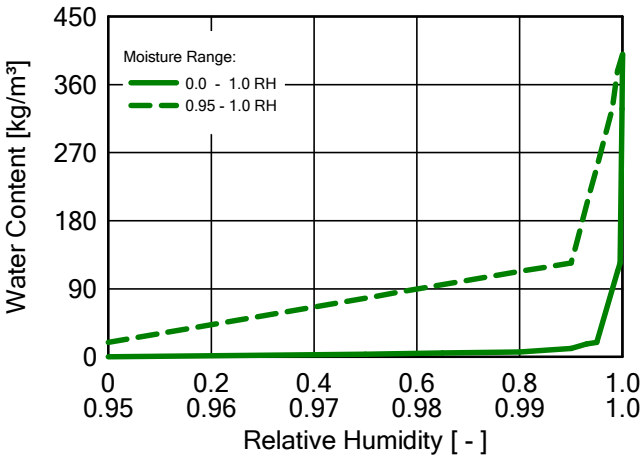
Material: Gypsum Board

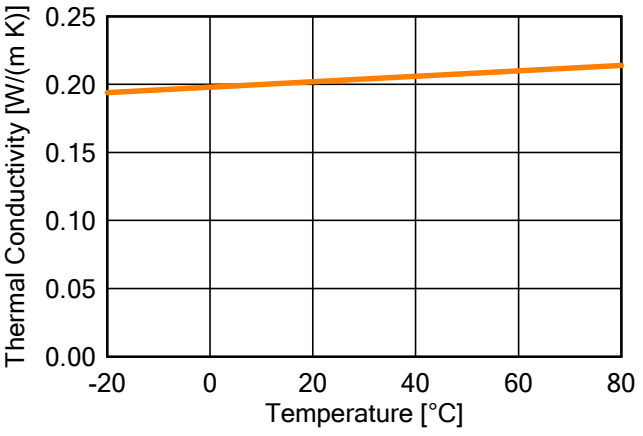
Property	Unit	Value
Bulk density	[kg/m³]	850
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4











Boundary Conditions

Exterior (Left Side)

Location:	Charleville_Airp_-Queensland-hour.wac
Temperature Shift:	0.0 °C
Orientation / Inclination:	South-East / 90 °

Interior (Right Side)

Indoor Climate:	ASHRAE 160P Air-conditioning; 2,8 °C; 21,1 °C; 23,9 °C M.Rate 1.05E-4 kg/s; A.Ch.Rate 0.2 1/h; Vol. 500 m³ Humidity Ratio Wo -1.0000 kg/kg

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Transfer Coefficient - includes long-wave radiation	External Wall	[W/(m² K)]	17 yes
sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	white, bright hue (DIN 410	[-]	0.4
Long-Wave Radiation Emissivity	white, bright hue (DIN 410	[-]	----
Adhering Fraction of Rain	Depending on inclination o	[-]	0.7
Explicit Radiation Balance			no

Interior (Right Side)

Name	Description	Unit	Value
Heat Transfer Coefficient	External Wall	[W/(m² K)]	8
sd-Value	No coating	[m]	----

Sources, Sinks

Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

Name	Type		
Source1	*Moisture Source; Fraction of Rain Load*		
	Start Depth in Layer	[m]	0
	End Depth in Layer	[m]	.005
	Cut-Off at Free Water Saturation	[kg/m³]	280
	ANSI/ASHRAE standard 160	[%]	1

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	01/05/2024 2:15:53 pm
Computing Time	1 min,45 sec.
Begin / End of calculation	01/04/2024 / 01/04/2034
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -33.05
Integral of fluxes, right side (kr,dr)	[kg/m²]	6.6E-7 18.63
Balance 1	[kg/m²]	-28.44
Balance 2	[kg/m²]	-28.44

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	39.03	10.58	10.44	39.03

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
Wallpaper, acrylic	0.00	0.00	0.00	0.01
Cement Plaster (stucco, A-value: 0.5	70.00	10.25	6.59	230.80
Fiber Cement Sheathing Board	185.83	82.58	64.59	469.00
Concrete, C35/45	179.90	48.25	47.97	179.90
Fiber Cement Sheathing Board	185.83	49.70	43.52	470.69
Air Layer 20 mm	1.88	0.24	0.19	15.68
Gypsum Board	6.30	2.56	2.29	8.36

Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-11362.6
Heat Flux, right side	[MJ/m²]	349.49
Moisture Fluxes, left side	[kg/m²]	-33.05
Moisture Fluxes, right side	[kg/m²]	18.63

Hygrothermal Sources

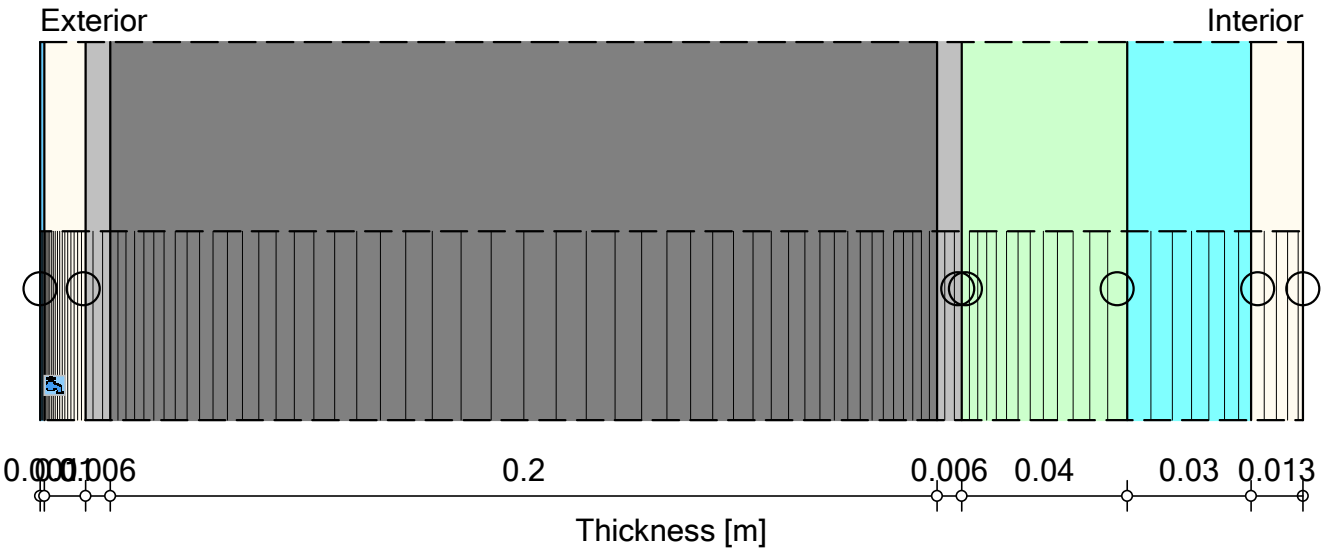
Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	23.236
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.0
Source1 (Moisture Source)	[kg/m²]	23.236

Project Data

Project Name	Ritek XL Series
Project Number	24-810
Client	Ritek Australia
Contact Person	Kevin Zia
City/Zip	
Street	
Phone	
Fax	
e-mail	
Responsible	
Remarks	
Date	18/04/2024

Component Assembly

Case: XL 150-138 Z5_insulation_SYD



- Monitor positions

- Heat/Moisture source/sink positions

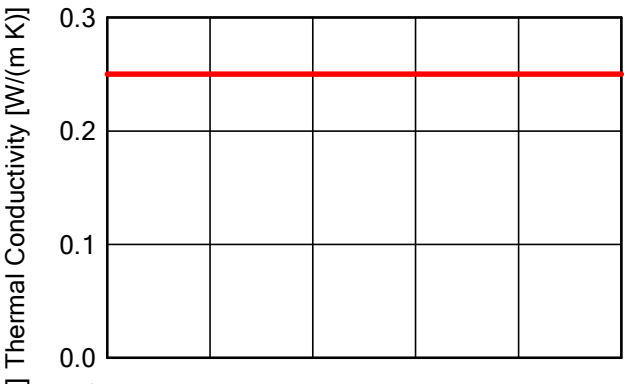
Materials:

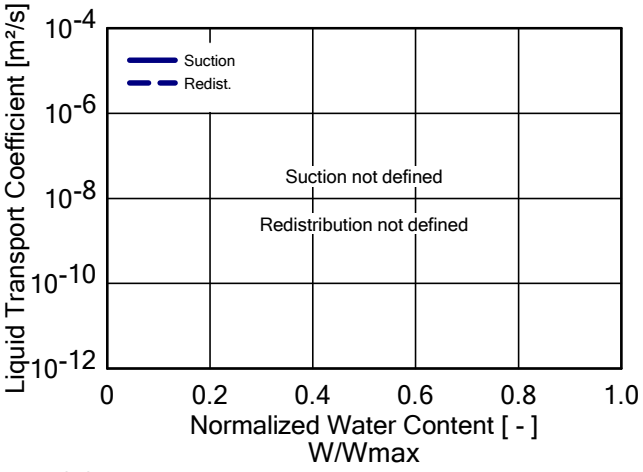
	- Wallpaper, acrylic	0.001 m
	- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
	- Fiber Cement Sheathing Board	0.006 m
	- Concrete, C35/45	0.2 m
	- Fiber Cement Sheathing Board	0.006 m
	- *Kingspan K12	0.04 m
	- Air Layer 30 mm	0.03 m
	- Gypsum Board	0.013 m

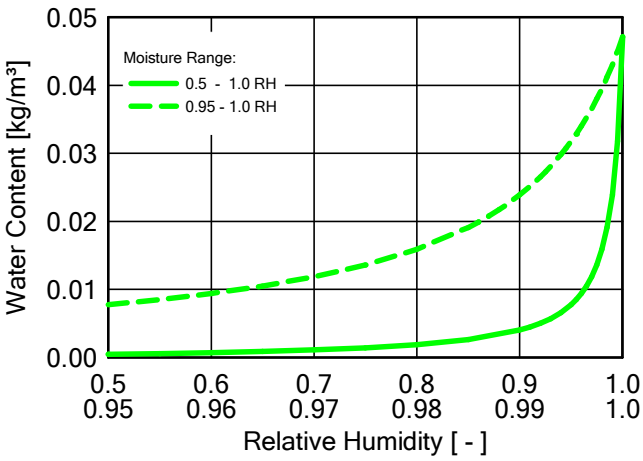
Total Thickness: 0.306 m
R-Value: 2.02 (m² K)/W
U-Value: 0.453 W/(m² K)

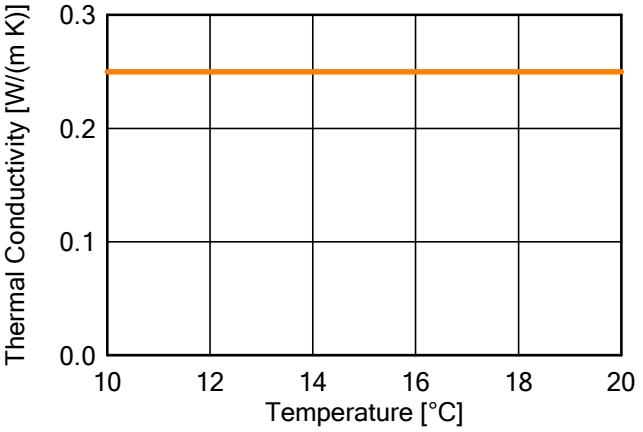
Material: Wallpaper, acrylic

Property	Unit	Value
Bulk density	[kg/m³]	930
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/(kg K)]	1260
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.25
Water Vapour Diffusion Resistance Factor	[-]	2100



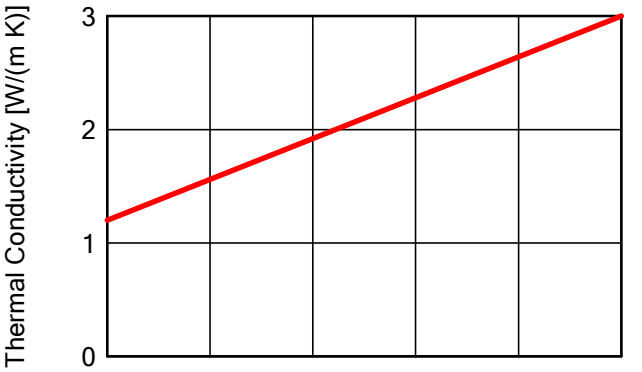


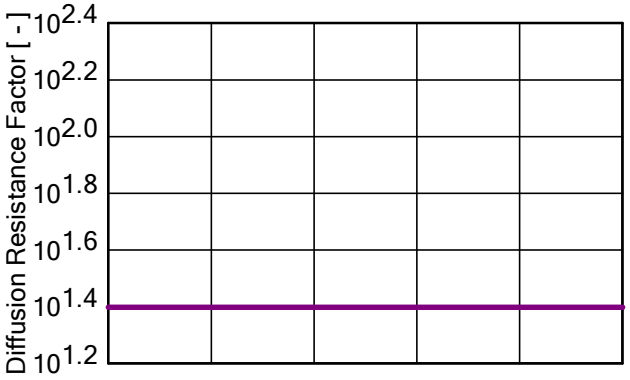


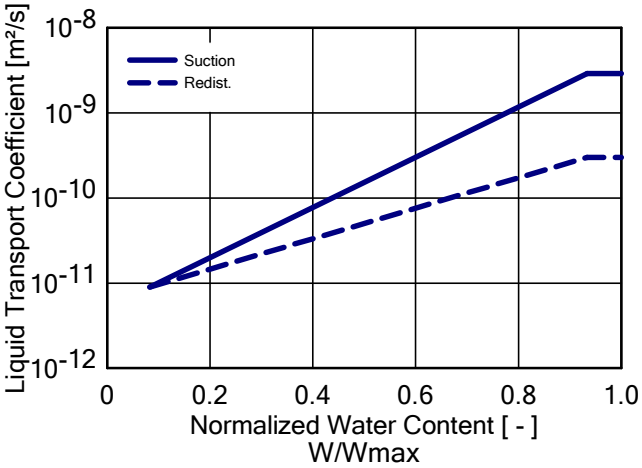


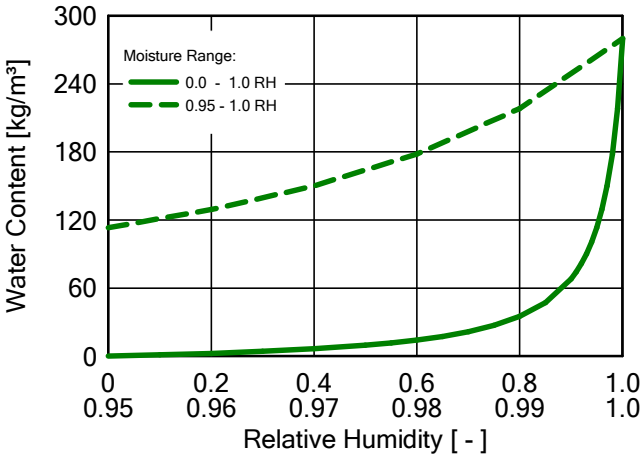
Material: Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

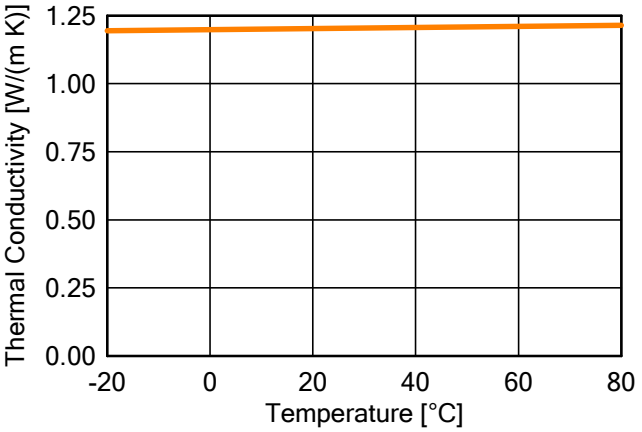
Property	Unit	Value
Bulk density	[kg/m³]	2000
Porosity	[m³/m³]	0.3
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.2
Water Vapour Diffusion Resistance Factor	[-]	25
Reference Water Content	[kg/m³]	35
Free Water Saturation	[kg/m³]	280
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	10
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





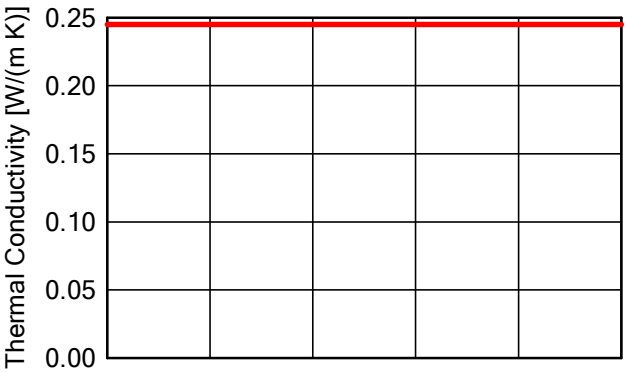


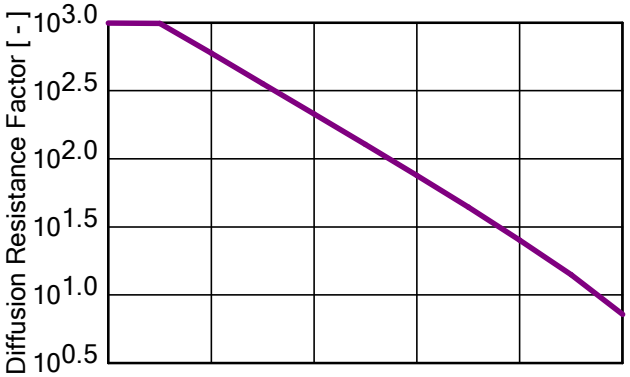


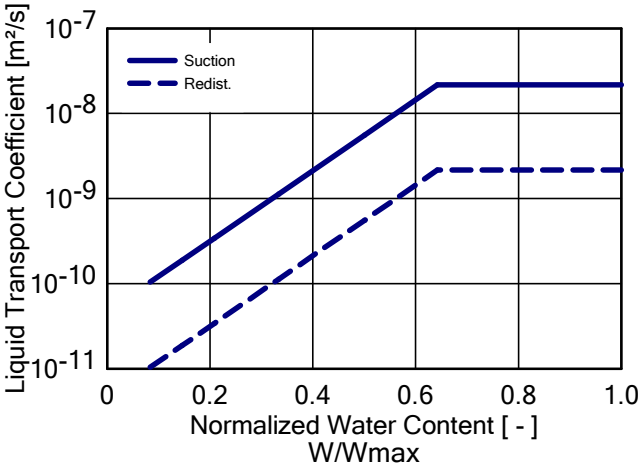


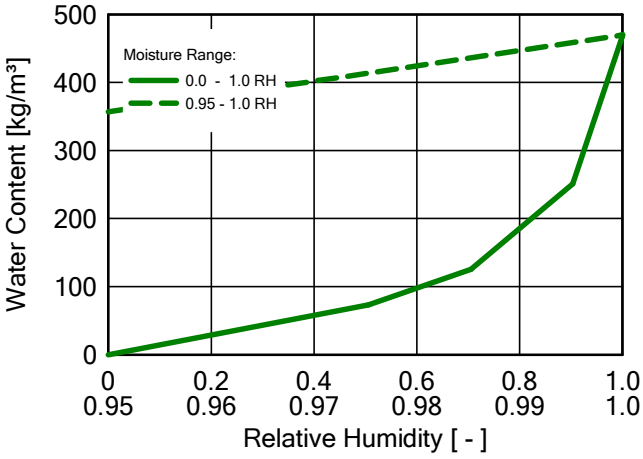
Material: Fiber Cement Sheathing Board

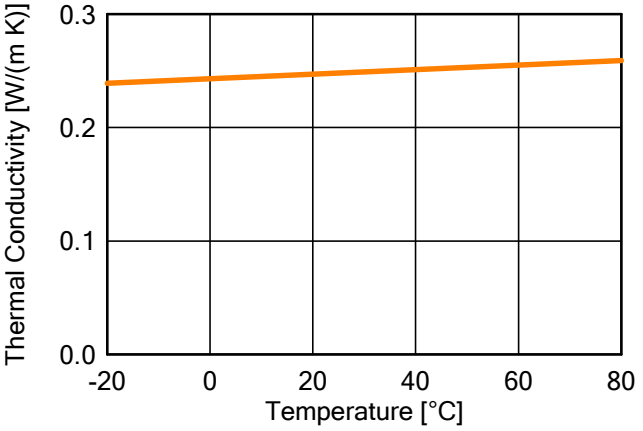
Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





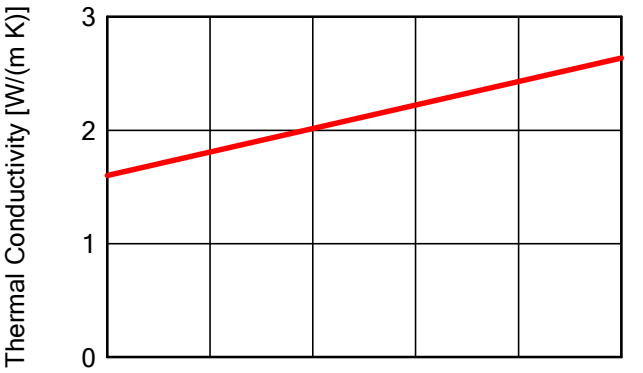


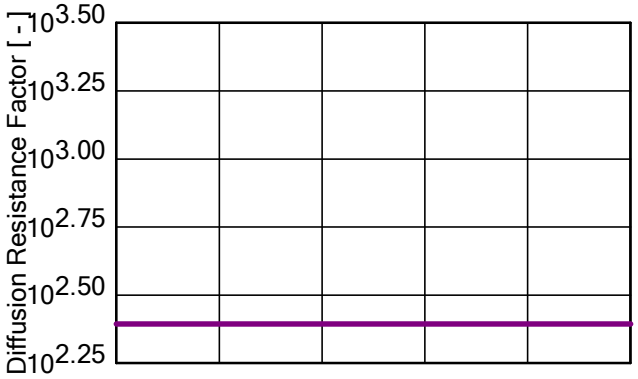


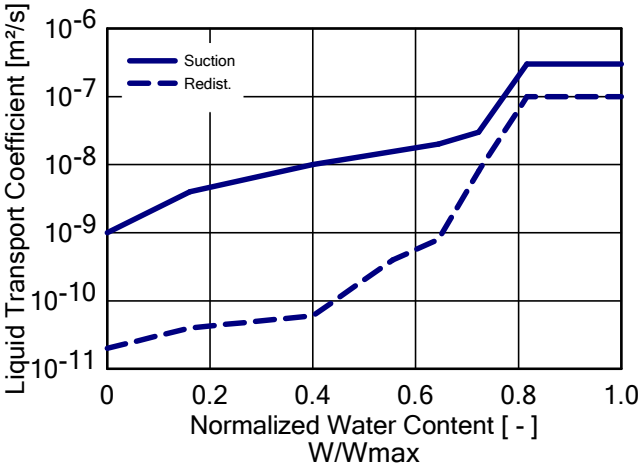


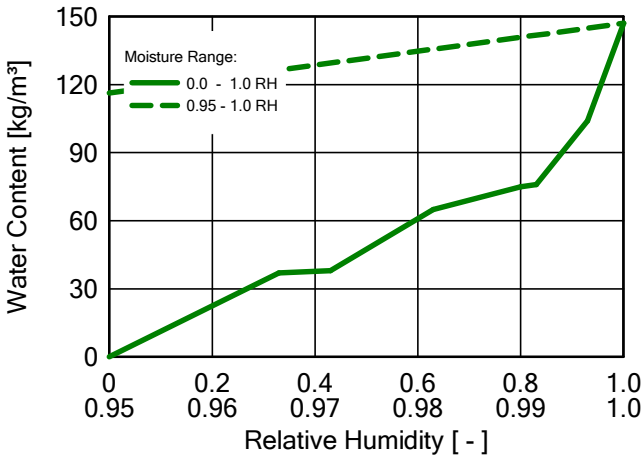
Material: Concrete, C35/45

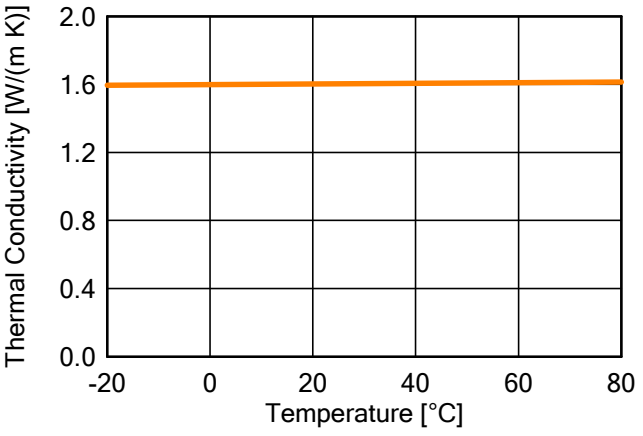
Property	Unit	Value
Bulk density	[kg/m³]	2220
Porosity	[m³/m³]	0.18
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.6
Water Vapour Diffusion Resistance Factor	[-]	248
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





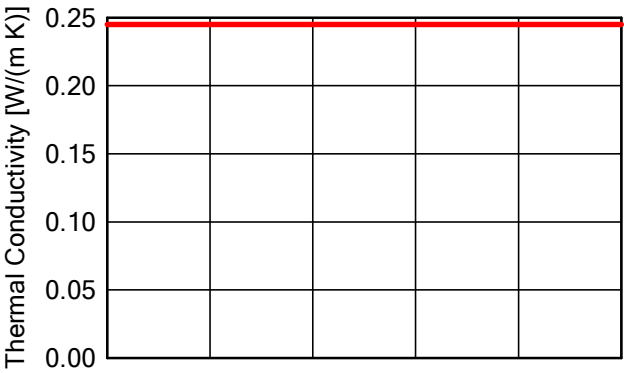


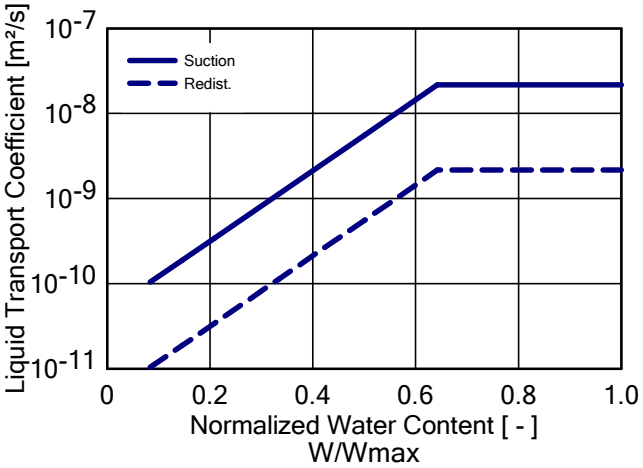


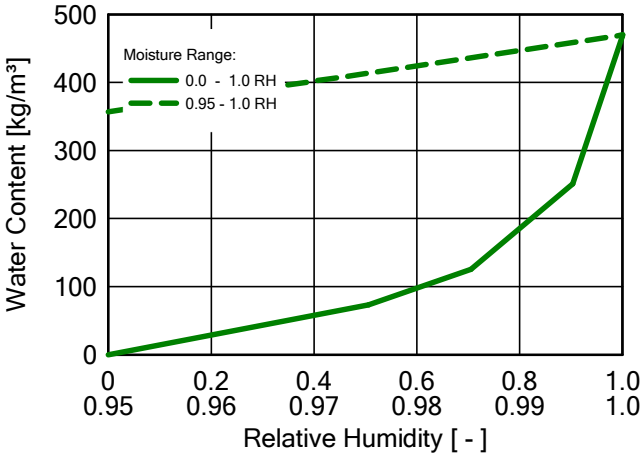


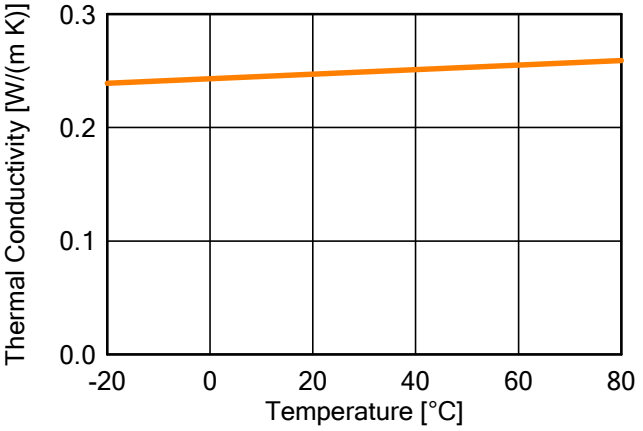
Material: Fiber Cement Sheathing Board

Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4



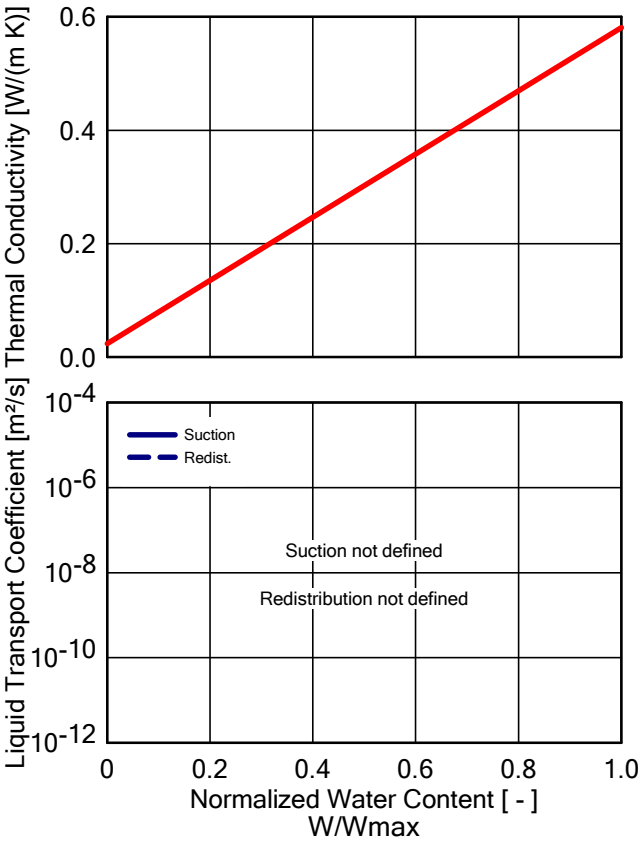


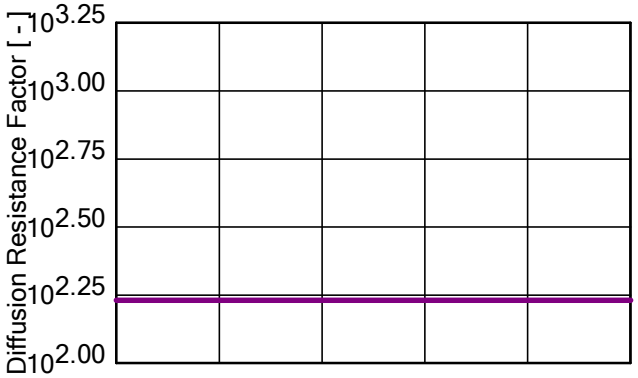


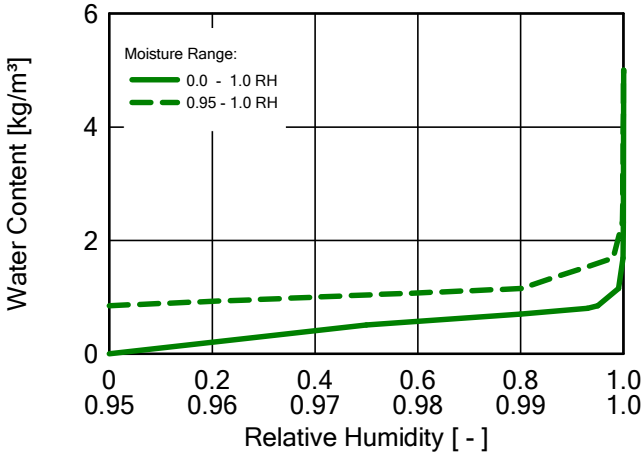


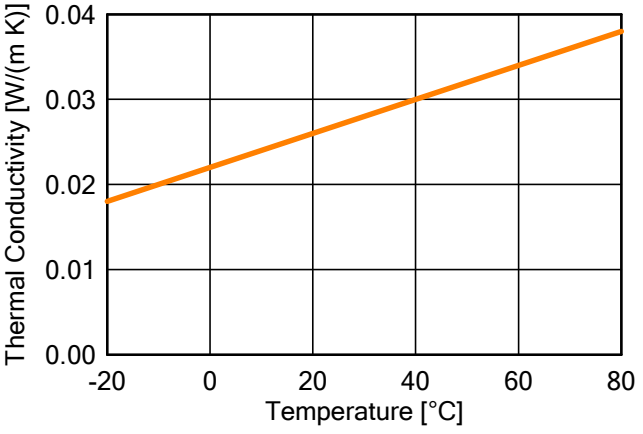
Material: *Kingspan K12

Property	Unit	Value
Bulk density	[kg/m³]	43
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/(kg K)]	1500
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.024
Water Vapour Diffusion Resistance Factor	[-]	170
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.05
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	0.0002



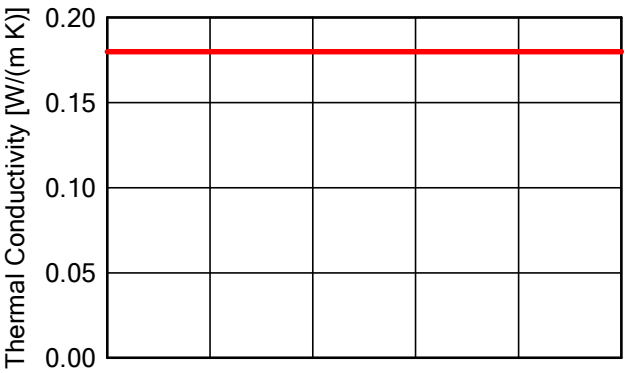


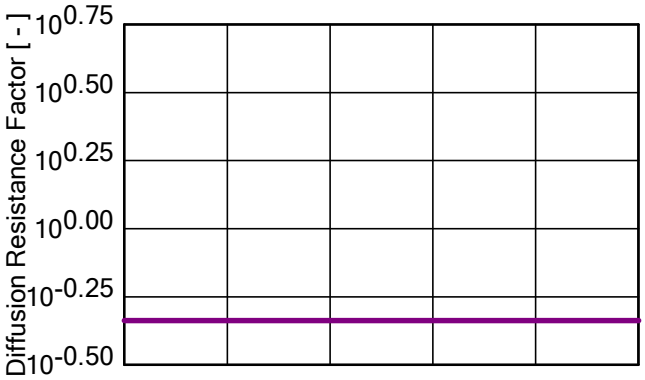


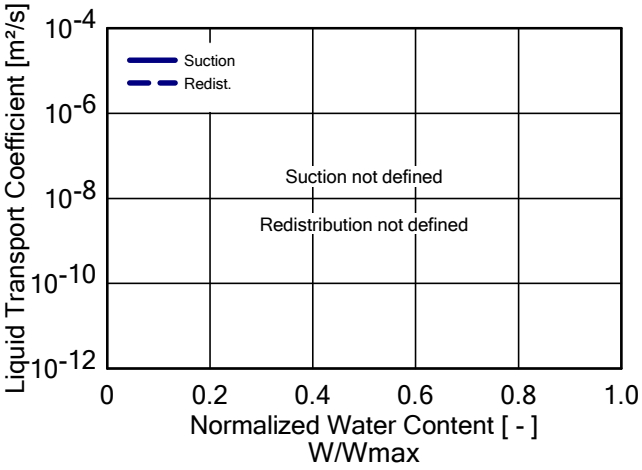


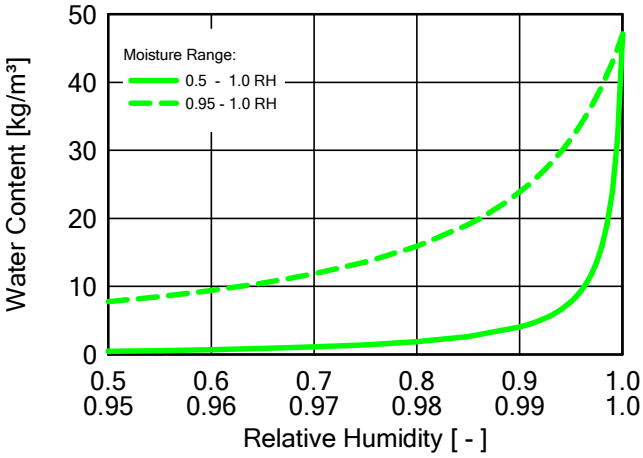
Material: Air Layer 30 mm

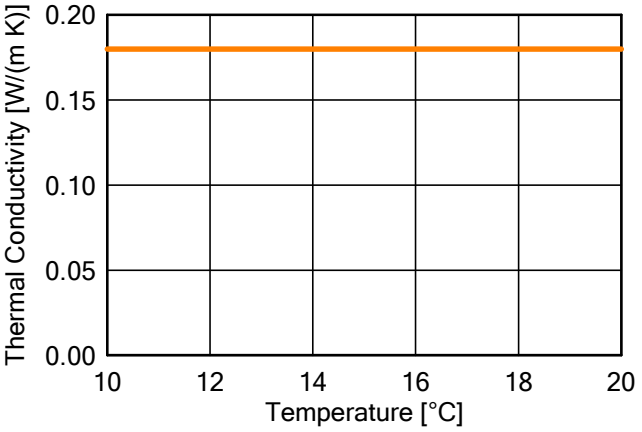
Property	Unit	Value
Bulk density	[kg/m³]	1.3
Porosity	[m³/m³]	0.999
Specific Heat Capacity, Dry	[J/(kg K)]	1000
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.18
Water Vapour Diffusion Resistance Factor	[-]	0.46





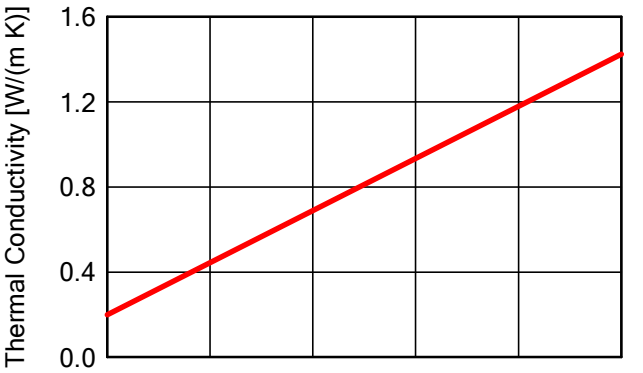


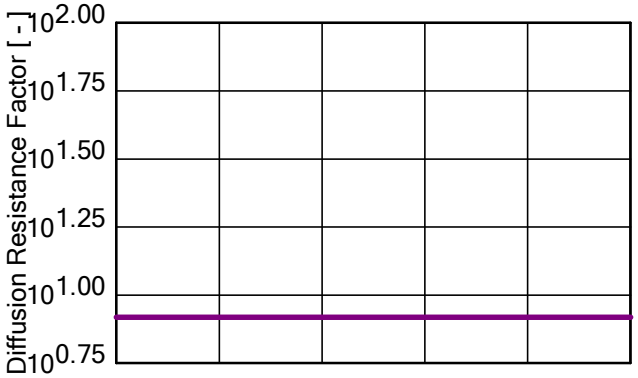


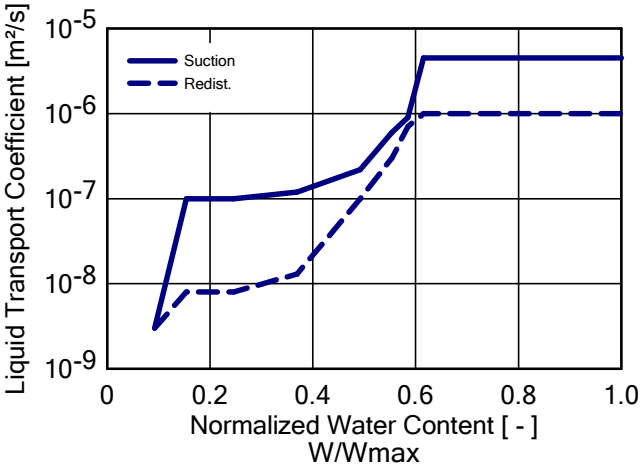


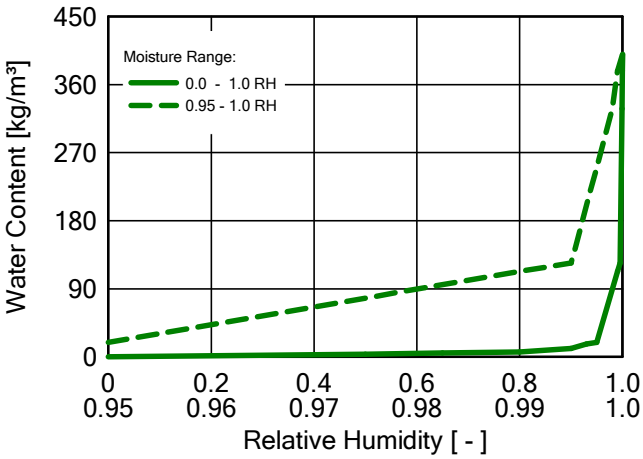
Material: Gypsum Board

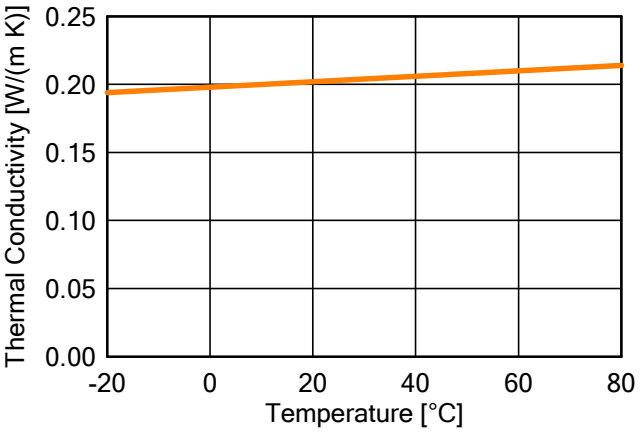
Property	Unit	Value
Bulk density	[kg/m³]	850
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4











Boundary Conditions

Exterior (Left Side)

Location: Sydney_Intl_Airp_-New South Wales-hour.wac
Temperature Shift: 0.0 °C
Orientation / Inclination: North-West / 90 °

Interior (Right Side)

Indoor Climate: ASHRAE 160P
Air-conditioning; 2,8 °C; 21,1 °C; 23,9 °C
M.Rate 1.05E-4 kg/s; A.Ch.Rate 0.2 1/h; Vol. 500 m³
Humidity Ratio Wo -1.0000 kg/kg

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Transfer Coefficient - includes long-wave radiation	External Wall	[W/(m² K)]	17 yes
sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	white, bright hue (DIN 410	[-]	0.4
Long-Wave Radiation Emissivity	white, bright hue (DIN 410	[-]	----
Adhering Fraction of Rain	Depending on inclination o	[-]	0.7
Explicit Radiation Balance			no

Interior (Right Side)

Name	Description	Unit	Value
Heat Transfer Coefficient	External Wall	[W/(m² K)]	8
sd-Value	No coating	[m]	----

Sources, Sinks

Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

Name	Type		
Source1	*Moisture Source; Fraction of Rain Load*		
	Start Depth in Layer	[m]	0
	End Depth in Layer	[m]	.005
	Cut-Off at Free Water Saturation	[kg/m³]	280
	ANSI/ASHRAE standard 160	[%]	1

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	01/05/2024 2:12:24 pm
Computing Time	1 min,39 sec.
Begin / End of calculation	01/04/2024 / 01/04/2034
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -63.44
Integral of fluxes, right side (kr,dr)	[kg/m²]	1.9E-7 6.37
Balance 1	[kg/m²]	-22.03
Balance 2	[kg/m²]	-22.03

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	39.07	17.04	16.99	39.08

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
Wallpaper, acrylic	0.00	0.00	0.00	0.02
Cement Plaster (stucco, A-value: 0.5	70.00	34.47	26.79	280.84
Fiber Cement Sheathing Board	185.83	182.69	172.10	470.82
Concrete, C35/45	179.90	73.90	73.90	179.90
Fiber Cement Sheathing Board	185.83	123.88	123.88	472.41
*Kingspan K12	0.70	0.56	0.56	8.31
Air Layer 30 mm	1.88	0.42	0.40	1.88
Gypsum Board	6.30	3.35	3.29	6.30

Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-16042.34
Heat Flux, right side	[MJ/m²]	-139.29
Moisture Fluxes, left side	[kg/m²]	-63.44
Moisture Fluxes, right side	[kg/m²]	6.37

Hygrothermal Sources

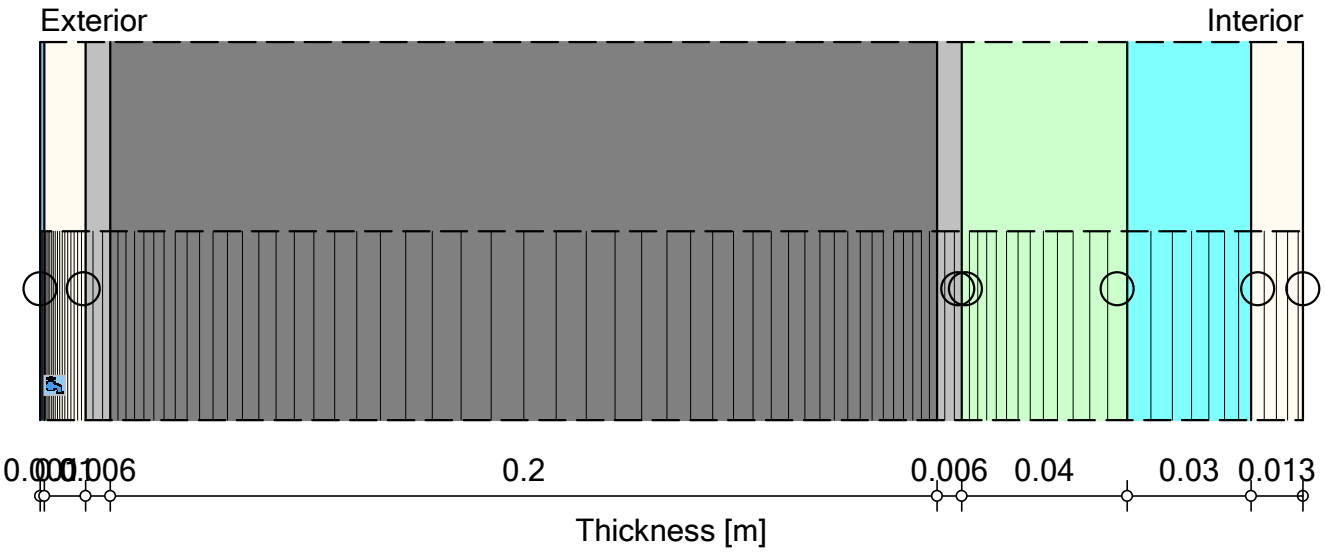
Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	47.916
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.181
Source1 (Moisture Source)	[kg/m²]	47.916

Project Data

Project Name	Ritek XL Series
Project Number	24-810
Client	Ritek Australia
Contact Person	Kevin Zia
City/Zip	
Street	
Phone	
Fax	
e-mail	
Responsible	
Remarks	
Date	18/04/2024

Component Assembly

Case: XL 150-138 Z6_insulation_Essendon (MEL)



- Monitor positions

- Heat/Moisture source/sink positions

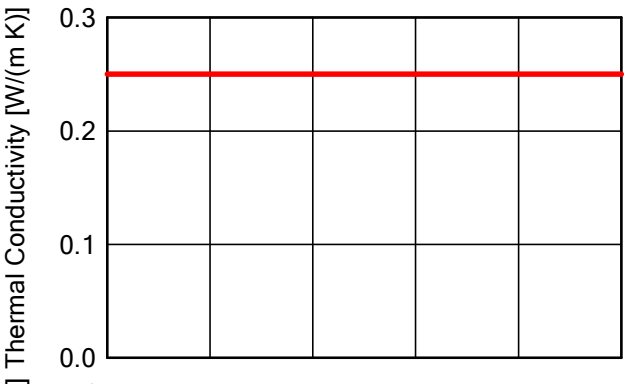
Materials:

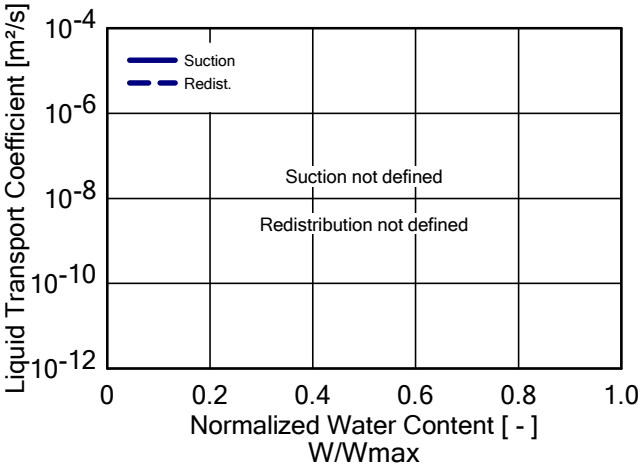
	- Wallpaper, acrylic	0.001 m
	- Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)	0.01 m
	- Fiber Cement Sheathing Board	0.006 m
	- Concrete, C35/45	0.2 m
	- Fiber Cement Sheathing Board	0.006 m
	- *Kingspan K12	0.04 m
	- Air Layer 30 mm	0.03 m
	- Gypsum Board	0.013 m

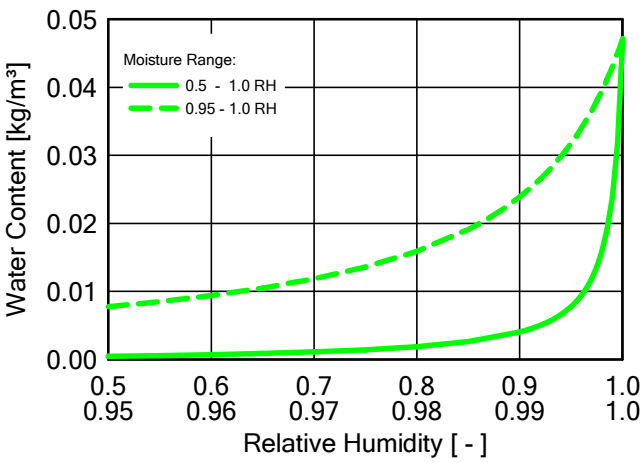
Total Thickness: 0.306 m
R-Value: 2.02 (m² K)/W
U-Value: 0.453 W/(m² K)

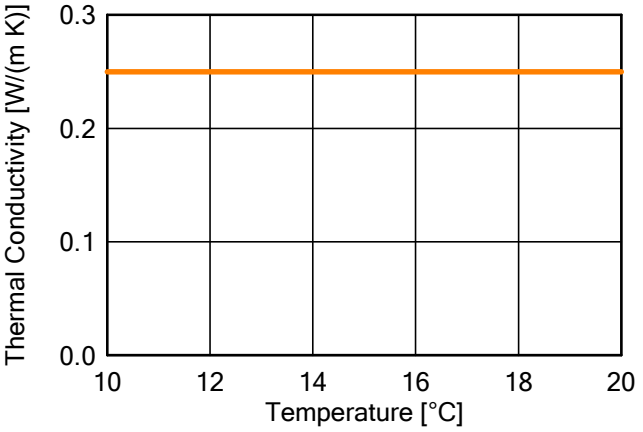
Material: Wallpaper, acrylic

Property	Unit	Value
Bulk density	[kg/m³]	930
Porosity	[m³/m³]	0.001
Specific Heat Capacity, Dry	[J/(kg K)]	1260
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.25
Water Vapour Diffusion Resistance Factor	[-]	2100



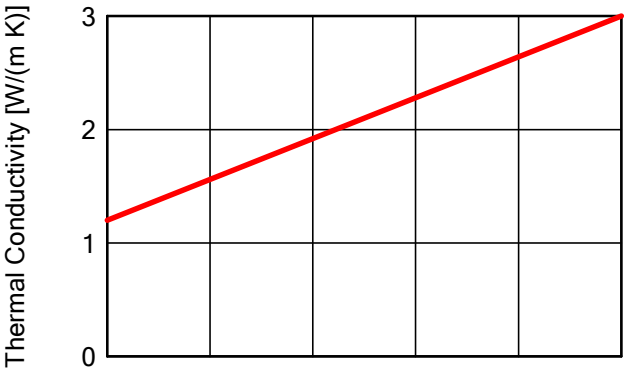


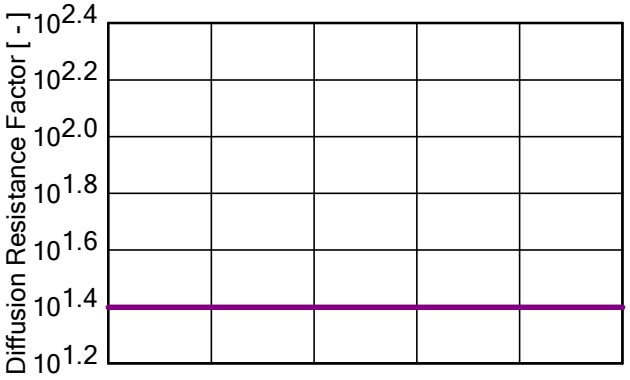


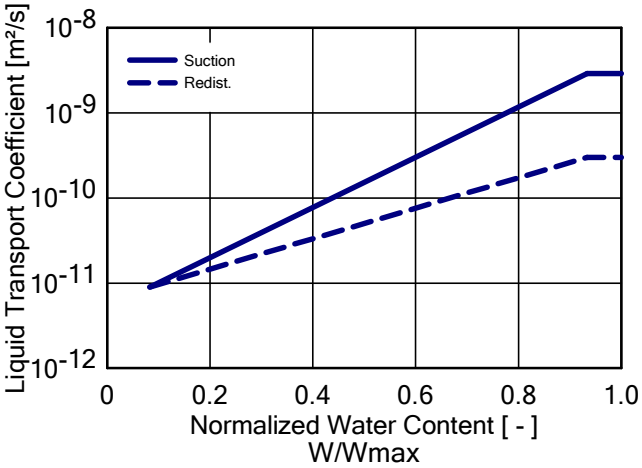


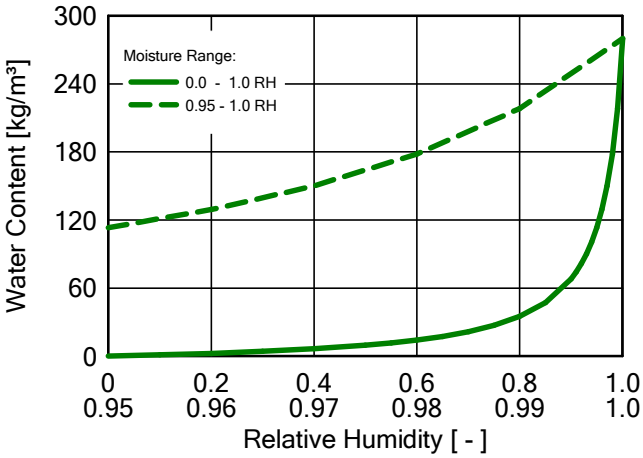
Material: Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

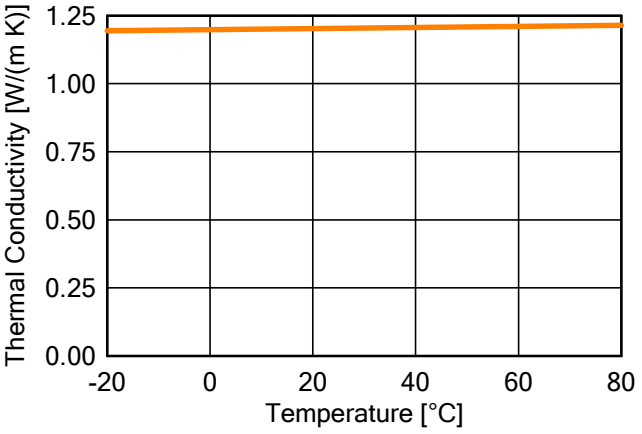
Property	Unit	Value
Bulk density	[kg/m³]	2000
Porosity	[m³/m³]	0.3
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.2
Water Vapour Diffusion Resistance Factor	[-]	25
Reference Water Content	[kg/m³]	35
Free Water Saturation	[kg/m³]	280
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	10
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





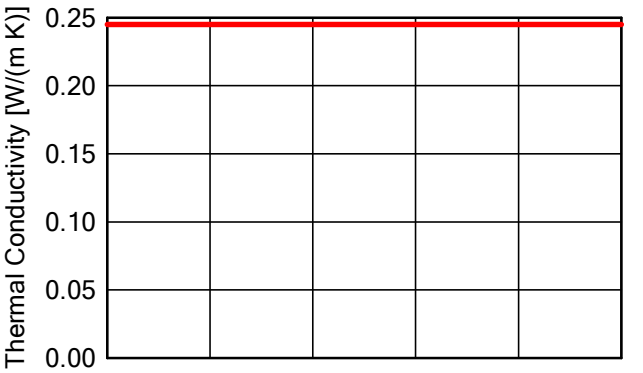


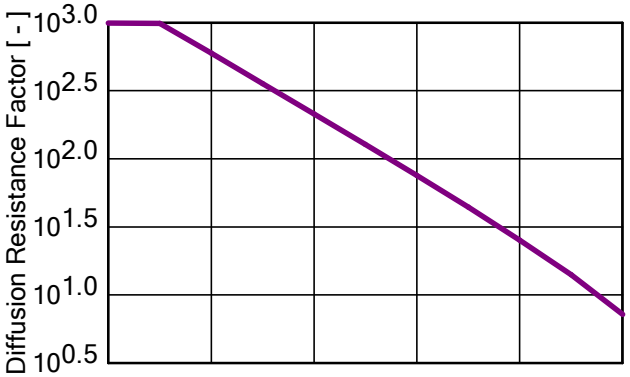


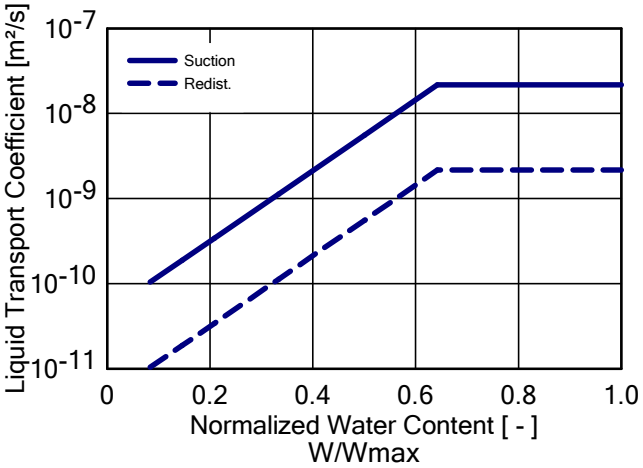


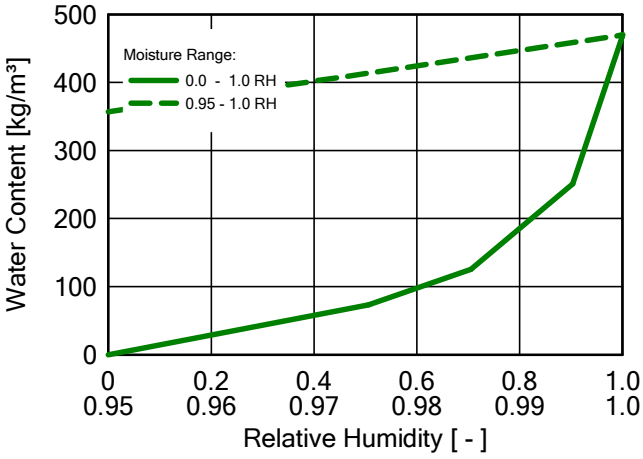
Material: Fiber Cement Sheathing Board

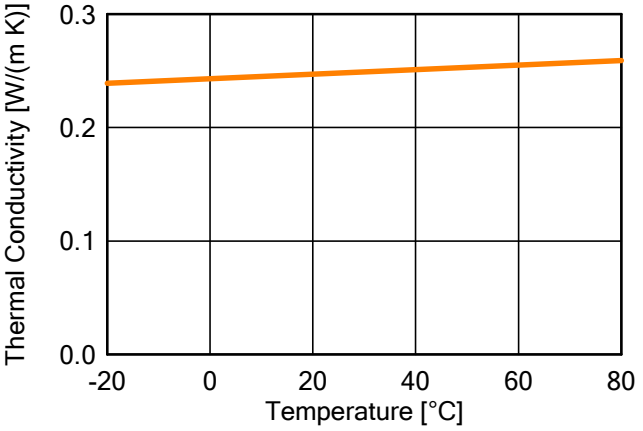
Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





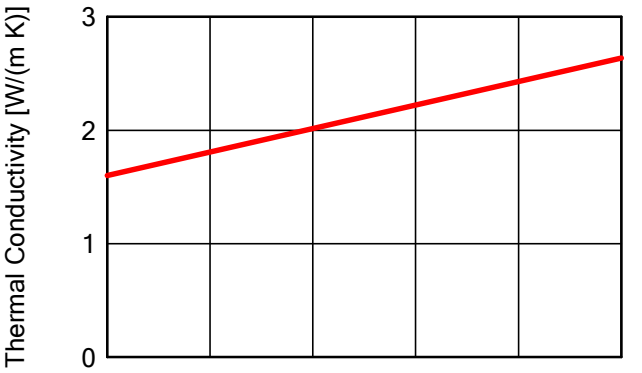


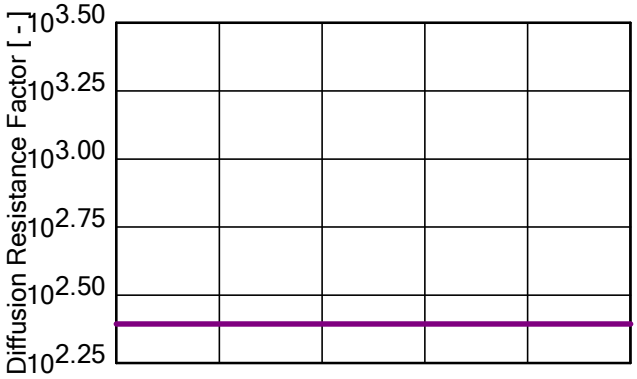


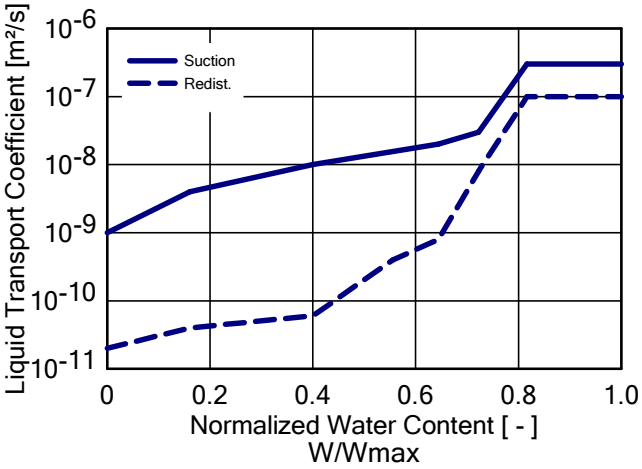


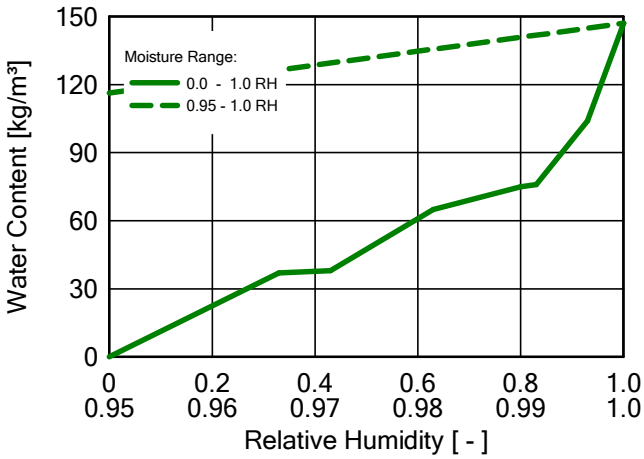
Material: Concrete, C35/45

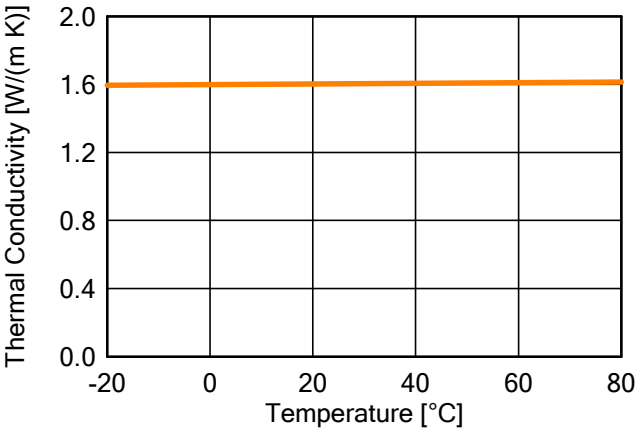
Property	Unit	Value
Bulk density	[kg/m³]	2220
Porosity	[m³/m³]	0.18
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	1.6
Water Vapour Diffusion Resistance Factor	[-]	248
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4





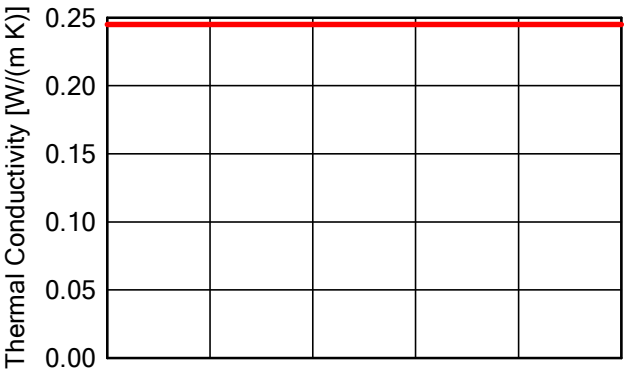


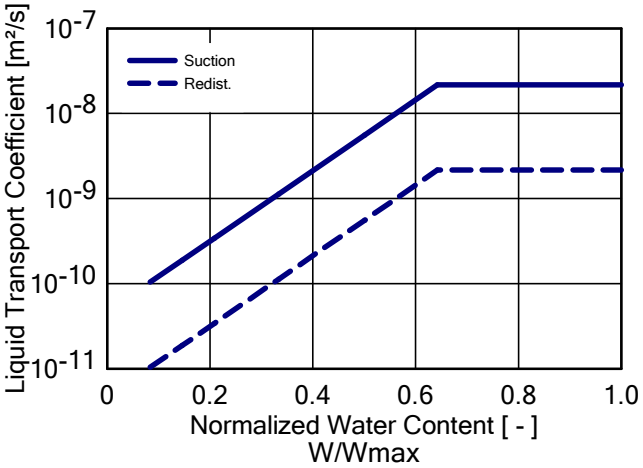


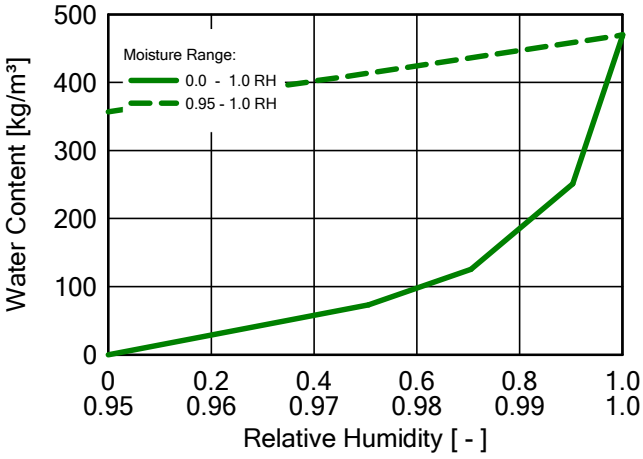


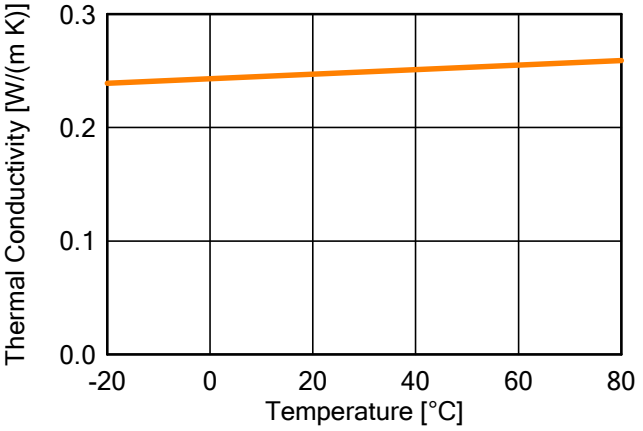
Material: Fiber Cement Sheathing Board

Property	Unit	Value
Bulk density	[kg/m³]	1380
Porosity	[m³/m³]	0.479
Specific Heat Capacity, Dry	[J/(kg K)]	840
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.245
Water Vapour Diffusion Resistance Factor	[-]	990.9
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4



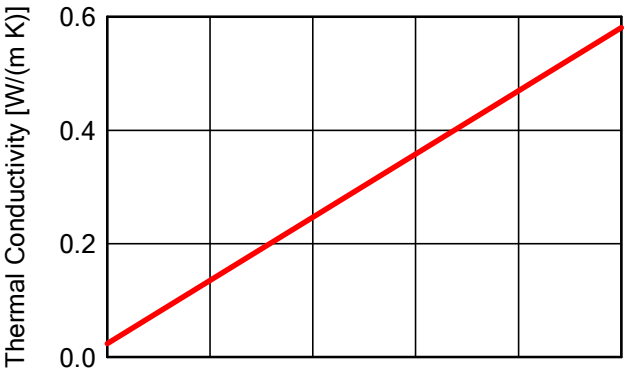


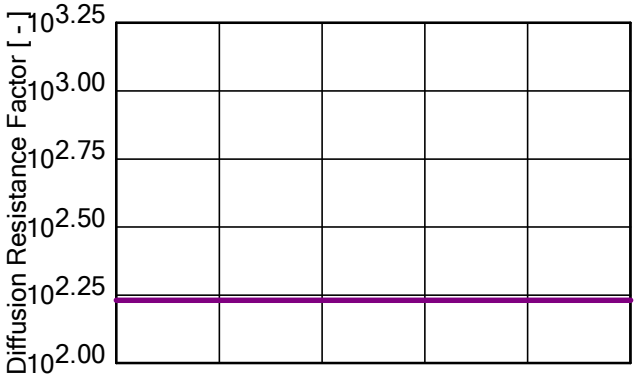


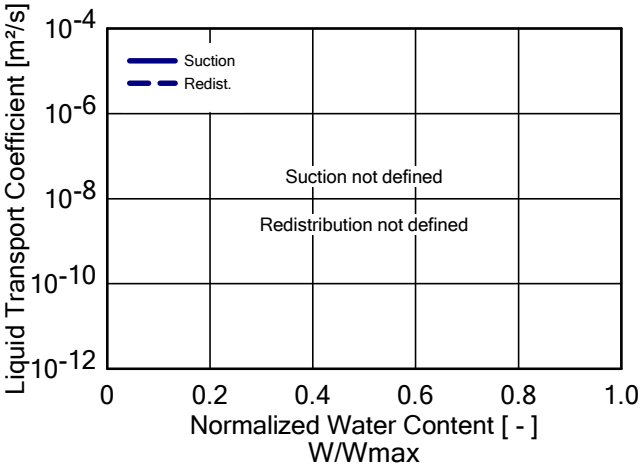


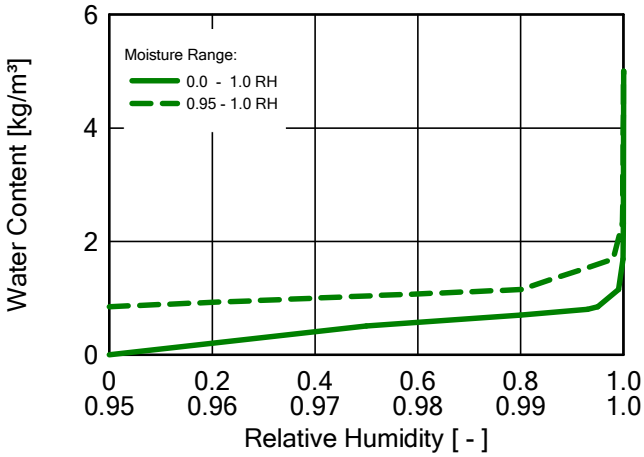
Material: *Kingspan K12

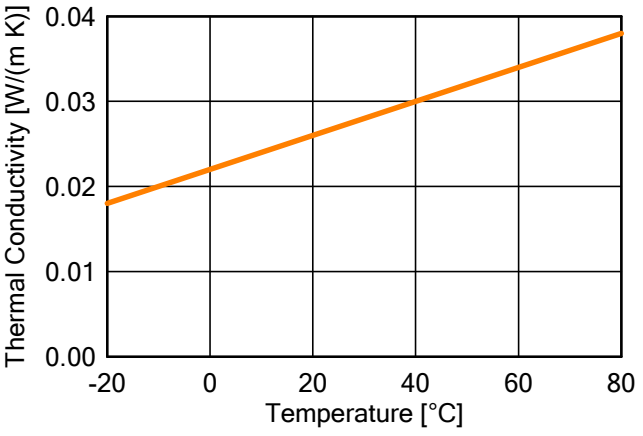
Property	Unit	Value
Bulk density	[kg/m³]	43
Porosity	[m³/m³]	0.95
Specific Heat Capacity, Dry	[J/(kg K)]	1500
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.024
Water Vapour Diffusion Resistance Factor	[-]	170
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	1.05
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	0.0002





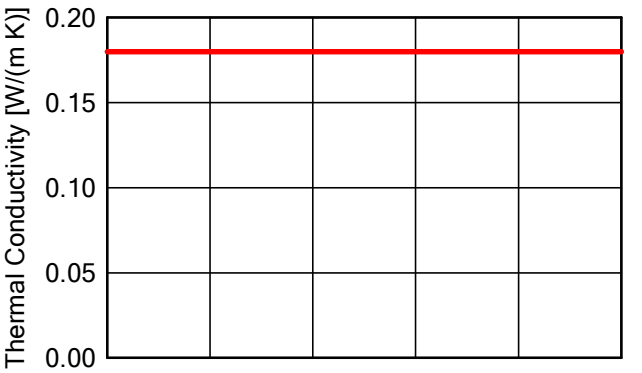


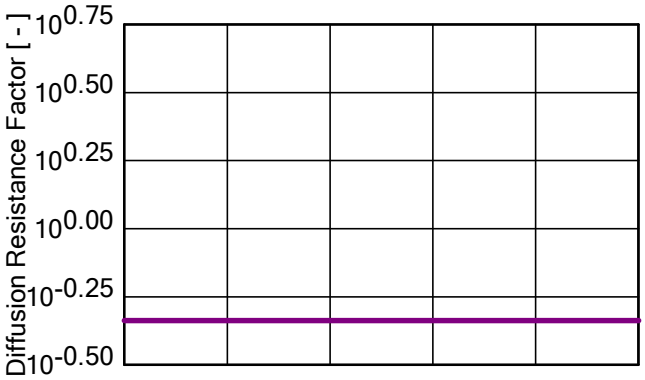


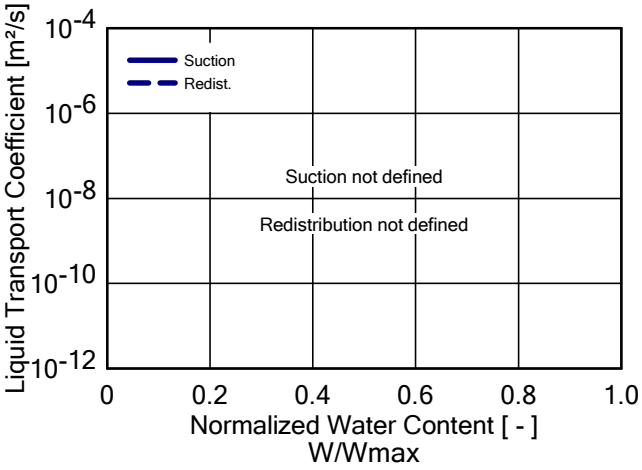


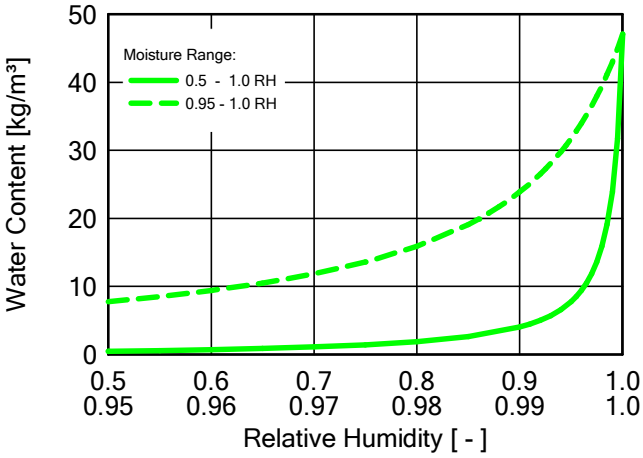
Material: Air Layer 30 mm

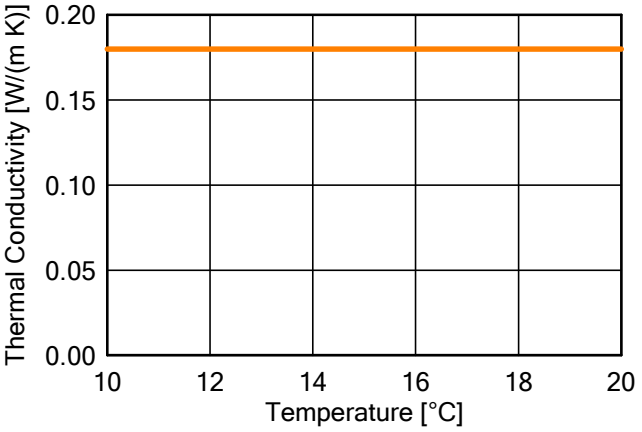
Property	Unit	Value
Bulk density	[kg/m³]	1.3
Porosity	[m³/m³]	0.999
Specific Heat Capacity, Dry	[J/(kg K)]	1000
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.18
Water Vapour Diffusion Resistance Factor	[-]	0.46





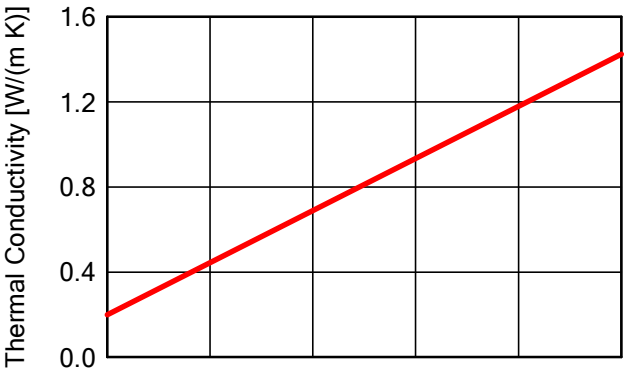


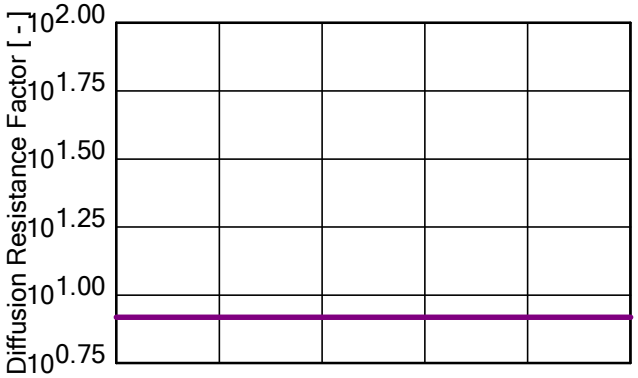


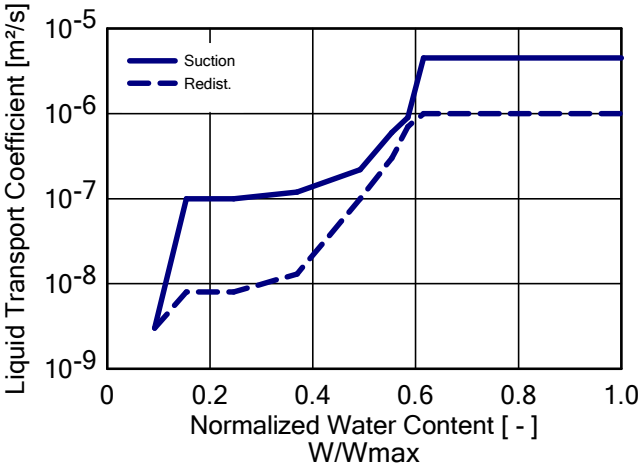


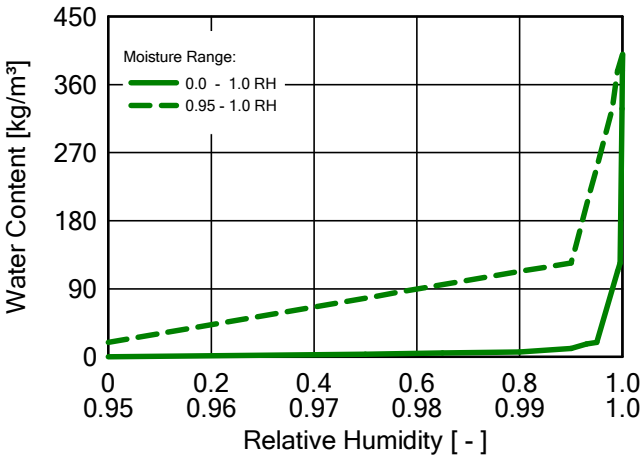
Material: Gypsum Board

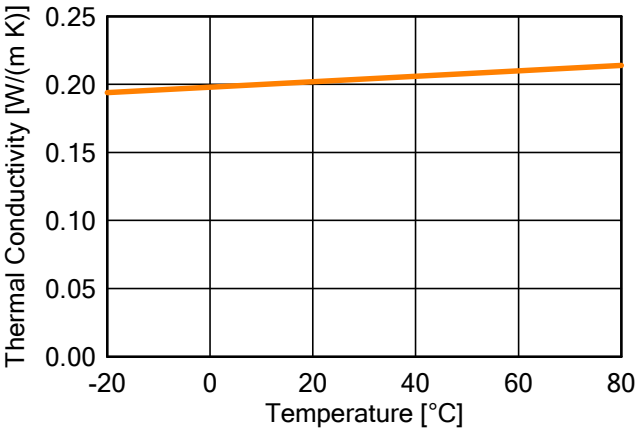
Property	Unit	Value
Bulk density	[kg/m³]	850
Porosity	[m³/m³]	0.65
Specific Heat Capacity, Dry	[J/(kg K)]	850
Thermal Conductivity, Dry, 10°C	[W/(m K)]	0.2
Water Vapour Diffusion Resistance Factor	[-]	8.3
Moisture-dep. Thermal Cond. Supplement	[%/M.-%]	8
Temp-dep. Thermal Cond. Supplement	[W/(m K²)]	2.00000E-4











Boundary Conditions

Exterior (Left Side)

Location:	MELBOURNE_ESSENDON-Victoria-hour.wac
Temperature Shift:	0.0 °C
Orientation / Inclination:	West / 90 °

Interior (Right Side)

Indoor Climate:	ASHRAE 160P Air-conditioning; 2,8 °C; 21,1 °C; 23,9 °C M.Rate 1.05E-4 kg/s; A.Ch.Rate 0.2 1/h; Vol. 500 m³ Humidity Ratio Wo -1.0000 kg/kg

Surface Transfer Coefficients

Exterior (Left Side)

Name	Description	Unit	Value
Heat Transfer Coefficient - includes long-wave radiation	External Wall	[W/(m² K)]	17 yes
sd-Value	No coating	[m]	----
Short-Wave Radiation Absorptivity	white, bright hue (DIN 410	[-]	0.4
Long-Wave Radiation Emissivity	white, bright hue (DIN 410	[-]	----
Adhering Fraction of Rain	Depending on inclination o	[-]	0.7
Explicit Radiation Balance			no

Interior (Right Side)

Name	Description	Unit	Value
Heat Transfer Coefficient	External Wall	[W/(m² K)]	8
sd-Value	No coating	[m]	----

Sources, Sinks

Cement Plaster (stucco, A-value: 0.51 kg/m2h0.5)

Name	Type		
Source1	*Moisture Source; Fraction of Rain Load*		
	Start Depth in Layer	[m]	0
	End Depth in Layer	[m]	.005
	Cut-Off at Free Water Saturation	[kg/m³]	280
	ANSI/ASHRAE standard 160	[%]	1

Results from Last Calculation

Status of Calculation

Calculation: Time and Date	01/05/2024 2:14:04 pm
Computing Time	1 min,48 sec.
Begin / End of calculation	01/04/2024 / 01/04/2034
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[kg/m²]	0.0 -43.85
Integral of fluxes, right side (kr,dr)	[kg/m²]	5.2E-7 2.61
Balance 1	[kg/m²]	-20.32
Balance 2	[kg/m²]	-20.32

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	39.07	18.76	18.76	39.07

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
Wallpaper, acrylic	0.00	0.00	0.00	0.18
Cement Plaster (stucco, A-value: 0.5	70.00	24.27	23.95	281.71
Fiber Cement Sheathing Board	185.83	160.08	157.80	470.85
Concrete, C35/45	179.90	80.78	80.78	179.90
Fiber Cement Sheathing Board	185.83	213.49	185.83	472.43
*Kingspan K12	0.70	0.68	0.61	8.33
Air Layer 30 mm	1.88	0.89	0.36	1.88
Gypsum Board	6.30	4.94	3.12	6.30

Time Integral of fluxes

Heat Flux, left side	[MJ/m²]	-13732.76
Heat Flux, right side	[MJ/m²]	-813.15
Moisture Fluxes, left side	[kg/m²]	-43.81
Moisture Fluxes, right side	[kg/m²]	2.61

Hygrothermal Sources

Heat Sources	[MJ/m²]	0.0
Moisture Sources	[kg/m²]	26.275
Unreleased Moisture Sources (due to cut-off)	[kg/m²]	0.85
Source1 (Moisture Source)	[kg/m²]	26.275