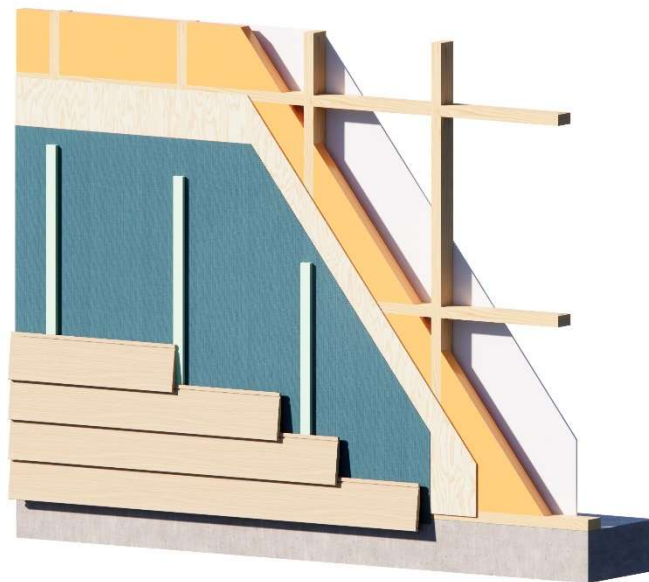


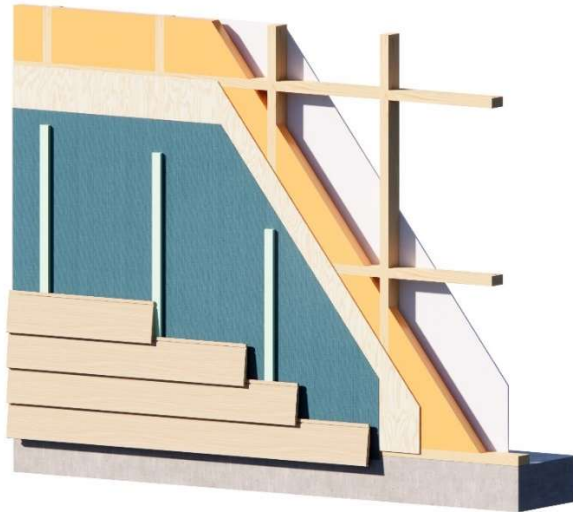
NZ Foam Warmcore wall Systems.



Business as Usual

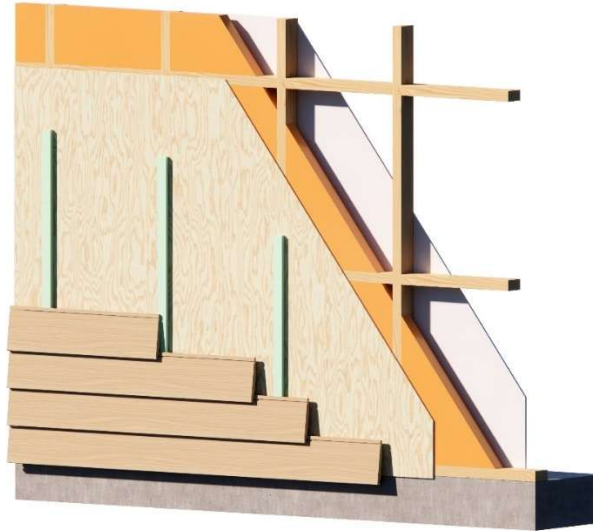


Standard Wall build up with H3 plywood.



- 90mm Timber framing.
- Standard Timber frames are supplied by framing manufacturers.
- H3 Plywood to be installed in accordance with the cladding manufacturer's installation guidelines.
- The building underlay to be installed following the manufacturer's installation guidelines.
 - Standard staples will be required.
- Warmcore insulation is installed as per manufacturer's instructions.
 - **R values can be achieved**
 - 50mm R 2.20
 - 70mm R 3.08
 - 100mm R4.40
- Cavity batten installed as cladding the cladding manufacturer's installation guidelines.
- Any cladding installed as per cladding manufacturer's installation guidelines.
- Plasterboard installed in accordance with the cladding manufacturer's installation guidelines.
- There is no requirement to install a vapour control membrane on the interior side of wall behind the plasterboard.
- Utilising Codemark Certifications for all products to create a compliant system.

Standard Wall build up with Eco plywood.

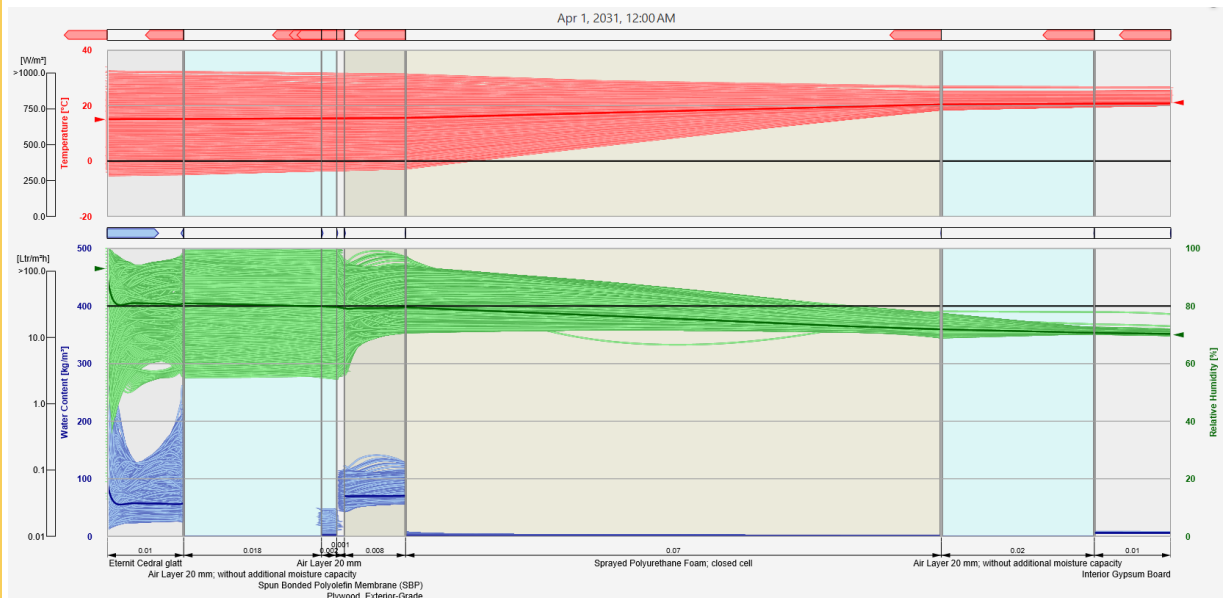


- 90mm Timber framing.
- Standard Timber frames are supplied by framing manufacturers.
- Eco Plywood to be installed in accordance with the cladding manufacturer's installation guidelines.
- All tapes are installed in accordance with the cladding manufacturer's installation guidelines.
- The building underlay to be installed following the manufacturer's installation guidelines.
 - Standard staples will be required.
- Warmcore insulation is installed as per manufacturer's instructions.
 - **R values can be achieved**
 - 50mm R 2.20
 - 70mm R 3.08
 - 100mm R4.40
- Cavity batten installed as cladding the cladding manufacturer's installation guidelines.
- Any cladding installed as per cladding manufacturer's installation guidelines.
- Plasterboard installed in accordance with the cladding manufacturer's installation guidelines.
- There is no requirement to install a vapour control membrane on the interior side of wall behind the plasterboard.
- Utilising Codemark Certifications for all products to create a compliant system.

NZ Foam Hygrothermal Analysis

NZ foam timber framed wall V1.2

3 bedroom townhouse at 45 Champion Street, Christchurch.



Compiled by Toby Brooke,
Reviewed by Jason Quinn, Director
30/04/2026
Sustainable Engineering Ltd



Purpose:

Sustainability Engineering Ltd. has conducted a hygrothermal analysis of the NZ Foam standard timber framed wall assembly. The Christchurch Moisture Design Reference Year (MDRY) climate (released November 2024 by MBIE) and an ASHRAE 160 residential indoor environment were used for this analysis.

ANSI/ASHRAE Standard 160-2021, Criteria for Moisture-Control Design Analysis in Buildings specifies criteria for predicting/mitigating/reducing moisture damage to the building envelope depending on climate, construction type, and HVAC system operation. This provides a framework for the hygrothermal analysis and mould failure criteria based on the current state of knowledge about mould growth. The failure criteria are intended to assess the risk level of a particular design approach while not being overly conservative.

This report describes and summarises the results of analysis and provides conclusions and recommendations about the moisture-related durability of overall assemblies for this building. E2 (external moisture) is outside of the scope of work and no bulk moisture (rainwater leaks) were considered in the analysis other than that specified in the ANSI/ASHRAE Standard 160-2021. Proper design of the E2 (external moisture) features of the design (such as flashings etc) remain the responsibility of the Architectural design team.

Summary:

The proposed assembly provisionally can meet the ASHRAE 160 performance standards for mould on the surface of the plywood only when modelled **assuming the plywood is pressure treated and this provides mould resistance equivalent to a durable sapwood**. This assembly reaches its hygrothermal limit when subjected to the mandatory 1% driving rain leakage required by ASHRAE 160. This is an assumption as the mould growth parameters of NZ sourced pressure treated plywood have not been measured.

When the mould model is rerun using spruce—which is estimated to be closer to treated plywood but still slightly conservative—the assembly achieves a pass, though it remains at the very edge of acceptable limits with a mould growth index exceeding 2 after 5 years. Assuming untreated pine sapwood is a definitive failure as the identified elevated moisture content within the plywood rigid air barrier, resulting in a mold growth index exceeding 4. This assembly failure for these less durable materials is driven by the 1% driving rain criteria and not the CCSF and any wall with external plywood under a WRB with similar permeability in this climate would have similar results.

Advice:

Recommend that test data for mould growth parameters for pressure treated plywood be obtained.

The foam is inherently airtight but installed in a timber frame as in this assembly it can crack away from the timber as the timber moves, allowing moist air to penetrate to the inside face of the plywood; the sensitive part of the assembly. There is no requirement to install a vapour control membrane on the interior side of the wall behind the plasterboard provided the CCSF is installed without debonding or shrinking away which can produce gaps. Gaps in the CCSF can cause localized moisture issues and/or airtightness issues.

The foam shall not be installed until the building is closed in. This is the drying procedure per ASHRAE 160.

Continuous ventilation exceeding 0.5ACH for the entire building should be maintained including during construction prior to the MVHR or continuous exhaust being commissioned. This can be done with fans or significant open window area at all times. The building must not be closed up during construction or the resulting condensation overnight can damage the structure and lead to mould.

Limitations:

The one-dimensional hygrothermal analysis was performed using WUFI Pro 6 and WUFI Finmould (previously called WUFI VTT) per ASHRAE 160-2021. This analysis models the coupled heat and moisture diffusion and capillary effect through the assemblies and assumes that the construction is airtight (no bulk air leaks) and there is no bulk water intrusion. If the final building includes defects permitting air or water leaks through the weather/vapour/air/thermal control layers than these leaks could significantly increase the moisture risk.

Built-in construction moisture from materials not being stored adequately (timber left in the rain, insulation installed prior to weathertight construction) can significantly impact initial mould growth rates. It is recommended to store materials properly, not install fibre insulation until the building is weathertight, and allow sufficient ventilation and time for interior plaster/concrete work such as slab floors to dry before sealing the building for occupancy.

ASHRAE 160 is intended to “provide guidance on how to best design buildings with adequate moisture control features.” This is intended to reduce risk but does not eliminate it as unlike structural analysis where worst-case conservative loads are used for moisture analysis the “international consensus [is] the analysis should be predicated on loads that will not be exceeded 90% of the time.”

This report covers *only the specific building modelled* as changing the building form, location, occupancy, etc. will change the results.

ASHRAE160-2021 deals with rain penetration in walls only. Roof systems are to be designed and built such that there is no rainwater penetration. This analysis and the ASHRAE 160 standard assume that appropriate measures have been taken to limit bulk water entry into the building and building envelope and to resist damaging liquid water penetration from sources such as rainwater, ground water, flooding, ice dams, etc.

Note that internal conditions can cause surface mould and this is not preventable without control of internal conditions (ie conditioning including dehumidification). We recommend that internal surface mould risk should be assessed using an fRSI calculation and a building moisture balance per PHPP10 for the detailed construction assemblies planned.

As this is a one-dimensional hygrothermal simulation in general the metallic components are not modelled (fasteners etc.) and the risk of corrosion is not addressed in this report unless specifically required in the scope of work.

Proposed Assembly

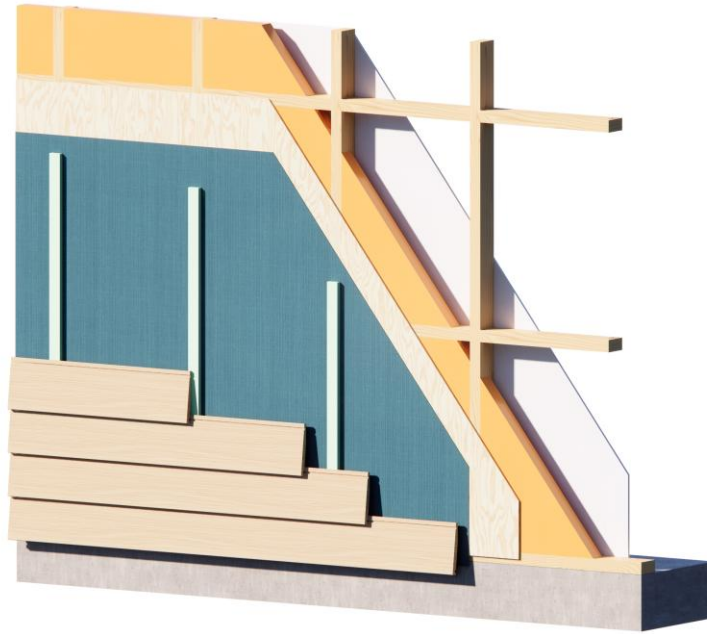


Figure 1: Proposed assembly with cladding / ventilated cavity / spun bonded polyolefin membrane / treated plywood / 90mm framing with 70mm of closed cell spray foam / plasterboard.

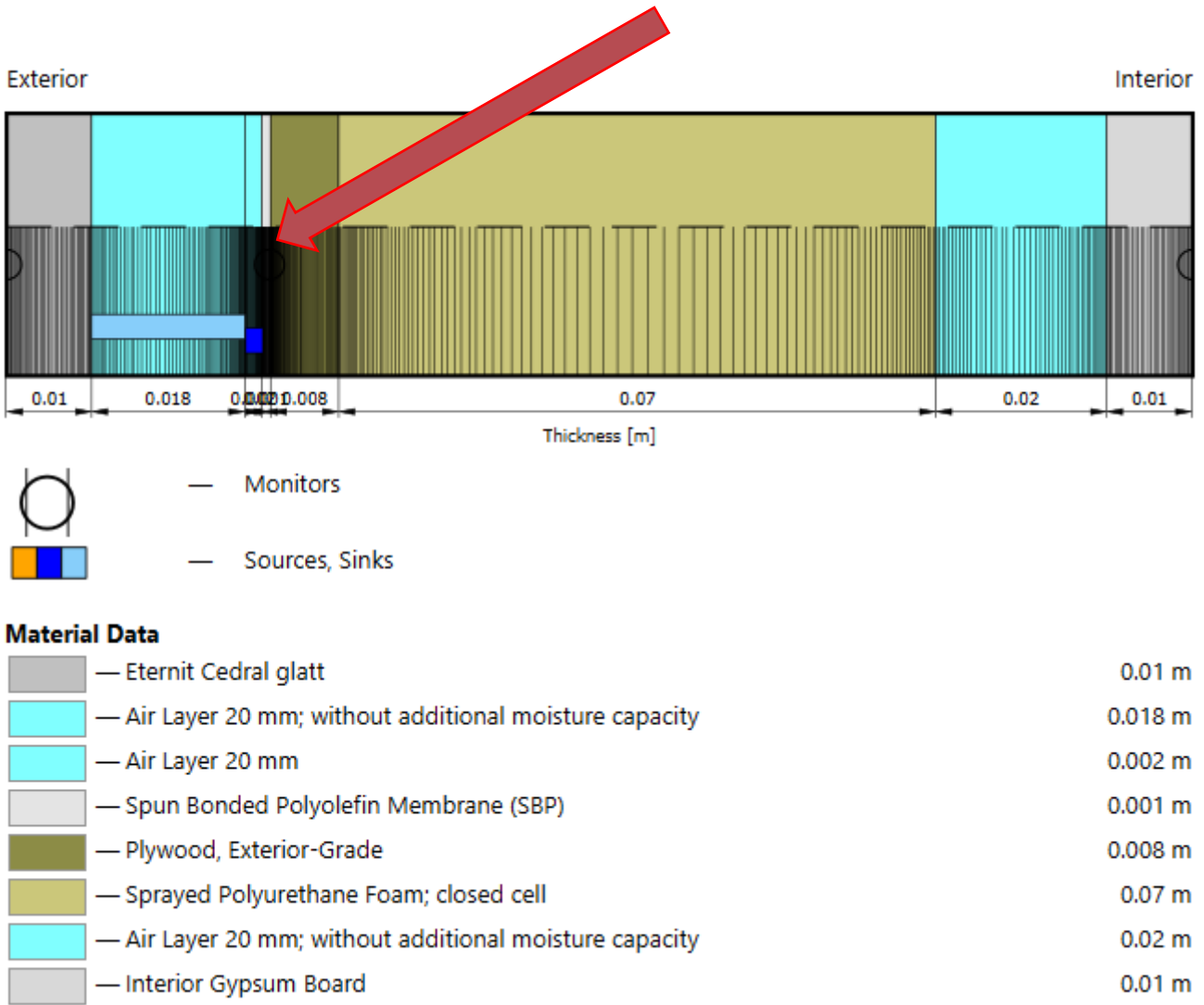


Figure 2: WUFI Inputs. WUFI analysis position indicated by the red arrow. Plywood at 2x EMC80 at the start of the model. All the remaining layers at EMC80.

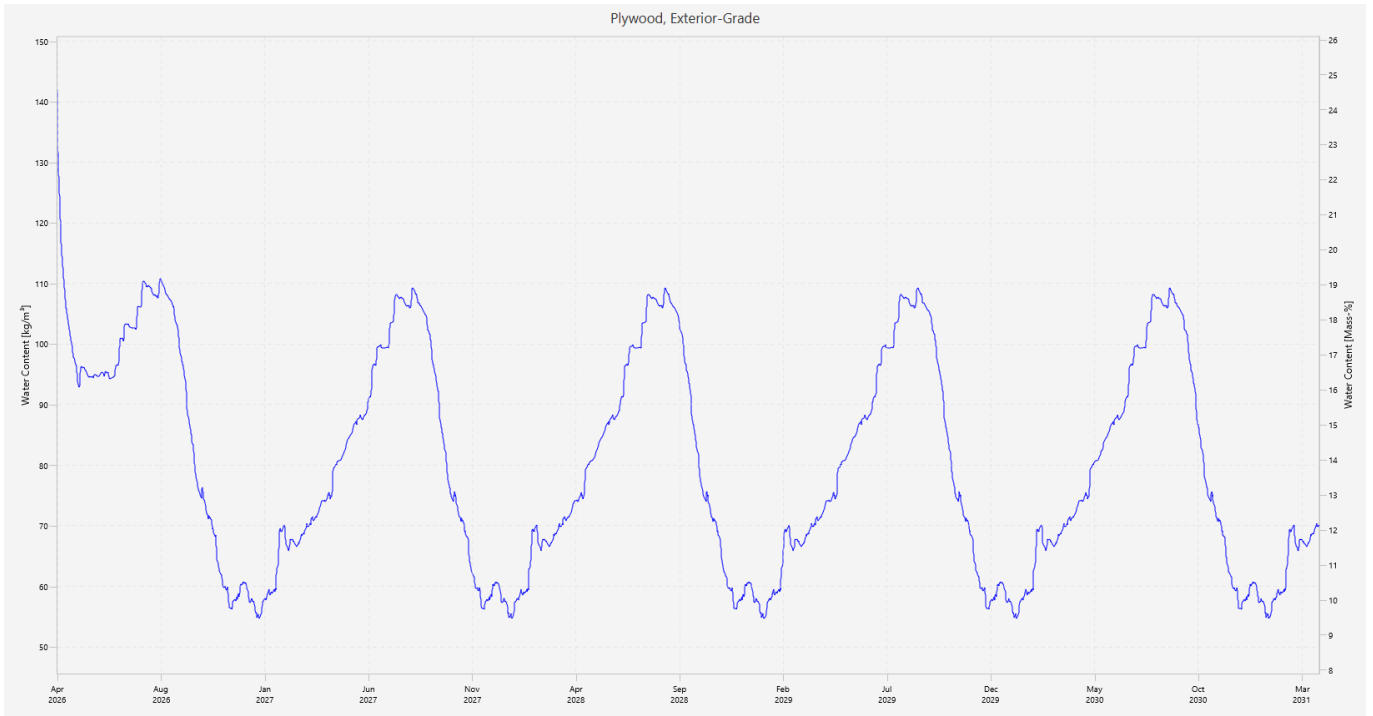


Figure 3: Water content in the plywood RAB, peaking around 19%, using 2024 MBIE MDRY climate data for Christchurch and 1% driving rain leakage.

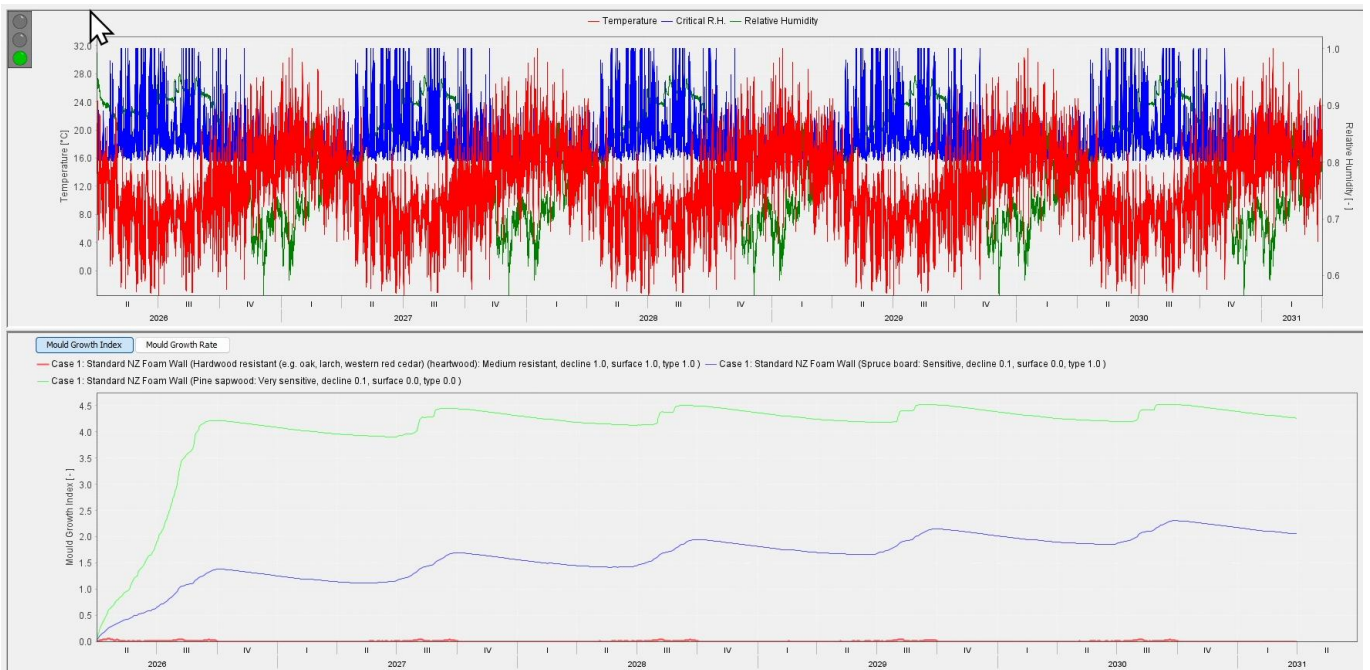


Figure 4: Mould growth index for the outer surface of the plywood with several materials assumed (MDRY climate, 1% driving rain). Assuming that the plywood is pressure treated to match a durable hardwood this would be acceptable. If you assume a lessor mould resistance of the surface such as spruce or untreated pine sapwood it would fail the ASHRAE criteria.

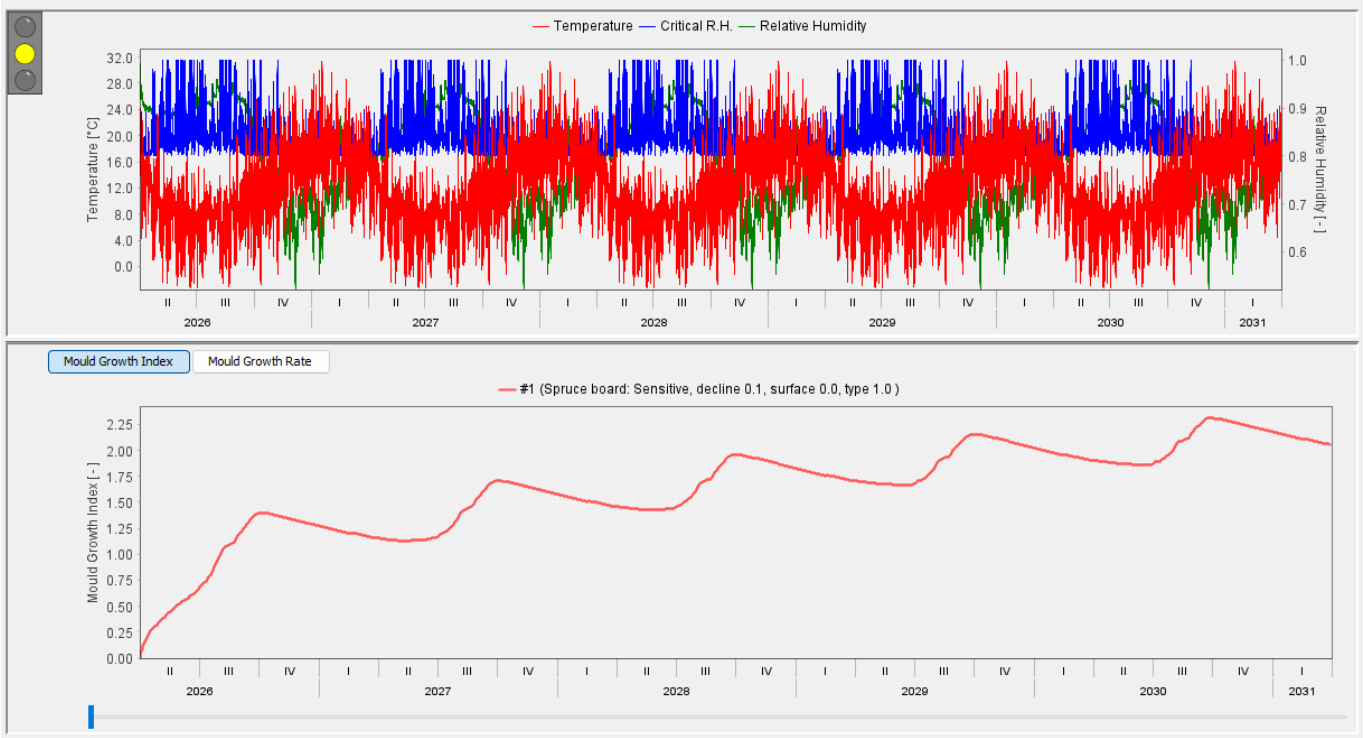


Figure 5: Mould growth index for the outer surface of the plywood with spruce (MDRY climate, 1% driving rain)

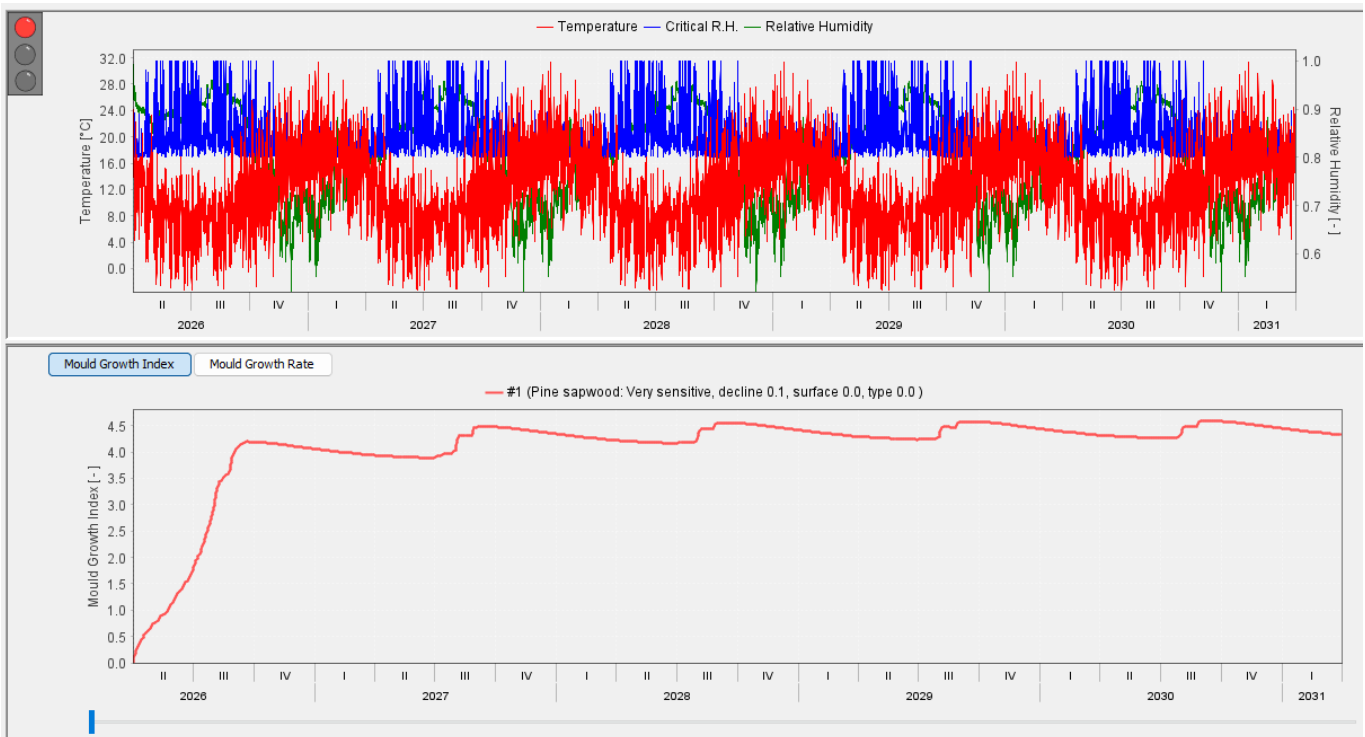


Figure 6: Mould growth index for the outer surface of the plywood with pine sapwood (MDRY climate, 1% driving rain)

Climate data

Exterior Climate

The Christchurch Moisture Design Reference Year (MDRY) has been used for this analysis:

A south facing orientation was chosen as per ASHRAE 160.

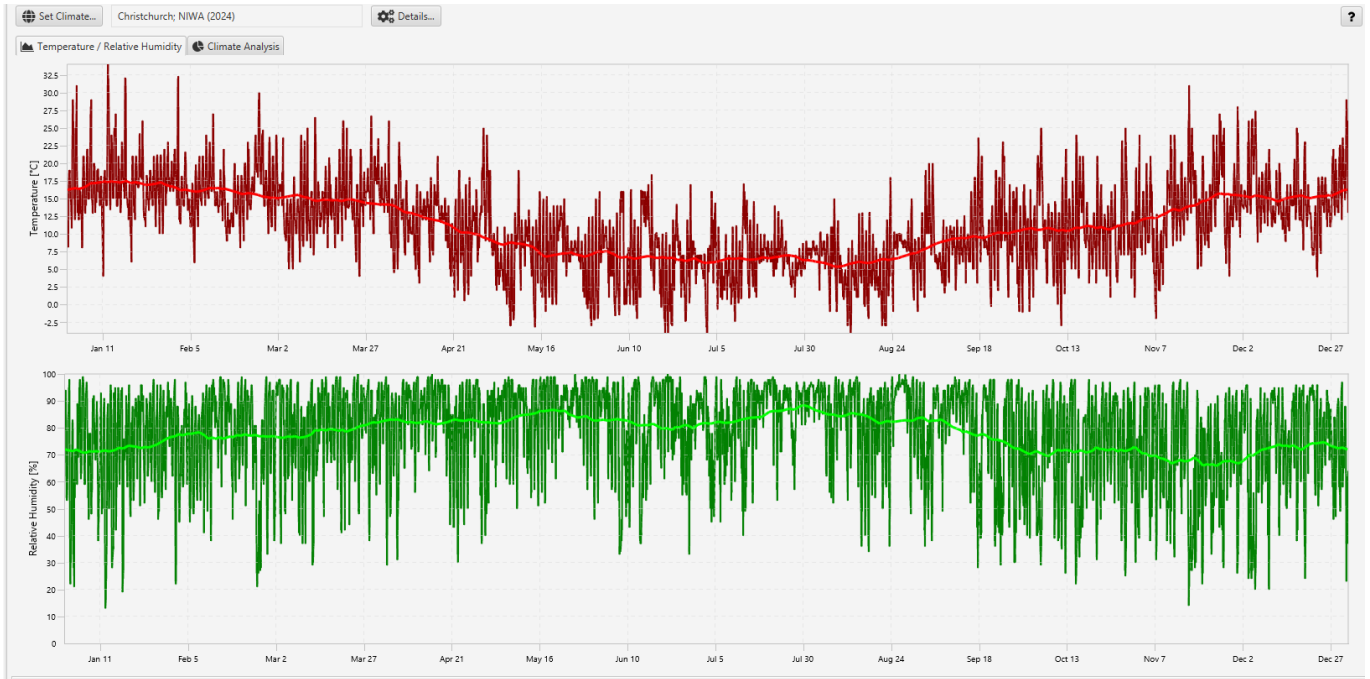


Figure 7: Exterior Climate in WUFI

ASHRAE 160-2021 notes:

Per section 6 the analysis shall be performed for a minimum of two orientations: the highest wind-driven rain and the wall with the lowest solar radiation (i.e. a south-facing wall for the southern hemisphere).

6.1 Moisture accumulation criteria. Simulation must be for minimum of 5 years and maximum of 10 years. The maximum total moisture content of the assembly shall be equal to or less than that of the prior year.

6.2 Conditions necessary to minimize mold growth. The mold index shall not exceed 3.0 on any surface in the assembly (excluding the exterior surface). As an additional criterion we do not recommend assemblies that fail this: The mold index calculated according to section 6.2 in ASHRAE 160-2021 shall not exceed a value of three (3) for the first year of simulation and must be equal to or below one (1) by the end of the second year of simulation and remain below one (1) after that in the initial period until the end of the first full year of simulation one (1) starting from the second full year of simulation. Note: These requirements are contrary to the ASHRAE 160 requirement in section 6.2 and are more restrictive. Mold spores are present with a mold index above three even if no mold is visible. This might be accepted for ASHRAE 160 compliance but we do not recommend these assemblies.

Unless measurements of in-situ moisture content are available the initial moisture content of construction materials in new construction to be used in calculations for this standard shall be two times equilibrium moisture

content at 90% relative humidity (EMC90) for concrete and two times EMC80 for all other materials. In retrofit applications, the initial moisture content of existing materials shall assume EMC90 for concrete and EMC80 for all other materials. If procedures to dry construction materials and/or procedures to protect construction materials and assemblies from wetting during construction are specified and ensured, the initial moisture content of new materials (in new or retrofit construction) shall assume EMC90 for concrete and EMC80 for all other materials.

EMC80 was used for spray foam as assumed to be installed once weathertight and all other materials EMC80x20.

20ACH in ventilated gaps and 3ACH in vented. Ventilated implies gap width of at least 25mm for brick or masonry claddings (with potential to block the cavity with mortar) and 10mm for all other claddings; Vented is the same with openings only on the bottom.

1% driving rain on rainscreen assemblies onto next WRB surface.

Note that the Australian AIRAH DA07 Criteria for Moisture Control Design Analysis document is based on ASHRAE 160-2019.

Appendix

Table 1: Building details

TFA [m2]	76
Volume [m3]	190
# bedrooms	3
Air change rate without MVHR [1/hr]	0.2
Absorptivity	0.51 – medium colour.

The screenshot displays the 'Air-conditioning system' configuration window in WUFI. It is divided into several sections:

- Air-conditioning system:** Includes a dropdown for 'AC Type' set to 'Heating only', a text input for 'floating indoor temperature shift [°C]' with the value 2,8, a text input for 'set point for heating [°C]' with the value 21,1, a text input for 'set point for cooling [°C]' with the value ---, and a text input for 'R.H. control setpoint [%]' with the value 70.
- Relative Humidity:** A sub-section header.
- Moisture Generation Rate:** Includes a spinner for 'number of bedrooms' set to 3, a checkbox for 'Jetted tub without exhaust fan' which is unchecked, a checkbox for 'User-defined Moisture Generation Ra...' which is unchecked, and a text input for 'Moisture Generation Rate [kg/s]' with the value 0.000116.
- Air Exchange Rate:** Includes a dropdown for 'standard construction' set to 'standard construction', a text input for 'Air Exchange Rate [1/h]' with the value 0.2, and a text input for 'building volume [m³]' with the value 190.

Figure 8: Building Details in WUFI



Figure 9: Interior Climate in WUFI

Status of Calculation

Calculation: Time and Date	Mar 24, 2026, 10:38 AM
Start / end of the computed time period	Apr 1, 2026 / Apr 1, 2031
Calculation Period	0:00:54.199
Currently simulated time step	Apr 1, 2031, 12:00 AM

Check for numerical quality

No. of Convergence Failures		0	
Sum of diffusive fluxes (left/right)	[kg/m ²]	-62.872	-3.358
Sum of capillary fluxes (left/right)	[kg/m ²]	60.950	0.000
Balance (mass vs. sum of surface-fluxes)	[kg/m²]	-0.554	-0.555

Water Content [kg/m²]

	Start	End	Min.	Max.
Total Water Content	1.827	1.276	0.815	2.656

Water Content [kg/m³]

Layer/Material	Start	End	Min.	Max.
Eternit Cedral glatt	53.780	58.107	23.715	155.525
Air Layer 20 mm; without additional moisture cap	0.010	0.014	8.5E-3	0.017
Air Layer 20 mm	1.880	1.855	0.466	47.065
Spun Bonded Polyolefin Membrane (SBP)	1.9E-3	1.8E-3	4.9E-4	0.017
Plywood, Exterior-Grade	142.000	69.981	54.366	142.000
Sprayed Polyurethane Foam; closed cell	0.700	0.999	0.700	2.103
Air Layer 20 mm; without additional moisture cap	0.010	0.012	0.010	0.014
Interior Gypsum Board	10.001	6.114	6.075	10.001

Figure 10: Computational Details from WUFI