Limestone Performance

2026

Facade Assembly Product Comparison · Upfront Carbon · Thermal · Acoustics

BRUHN

Contents

01 Introduction

This study focuses on finding insights into the carbon, thermal, and acoustic performance of selected wall assemblies through quantitative modelling analysis are intended to benchmark Bruhn Mount Gambier limestone systems against typical external walls systems.

Mount Gambier limestone is a fossiliferous limestone quarried from the Marte deposits found west of Mount Gambier in South Australia.

It is a sedimentary rock formed from aqueous deposits composed largely of the minerals calcite and aragonite, which are different crystal forms of calcium carbonate (CaCO3).

The shell limestone is predominantely light in colour but can range into deeper tones of cream to yellow or biscuit colour.

The stone originated from extensive colonies of lace coral that flourished on an open-marine shelf in shallow, calm and warm waters.

It has been estimated to have formed over 30 million years ago and its composition consists of bryozoa, foraminifea and echinoid spines and plates. It has a dense and consistent texture with shelly matter evident in its surface.

Image, next page: Wulanda Recreation & Convention Centre

Purpose

The purpose of this study is to identify and evaluate a range of competitive external wall assemblies that can be benchmarked against Bruhn Mount Gambier Limestone products in terms of upfront carbon, thermal performance, and acoustic performance.

Two building typologies have been considered in the comparison:

Single residential (Class 1) – comparative wall assemblies evaluated against the Bruhn Mount Gambier Limestone 100 mm thick double block wall system.

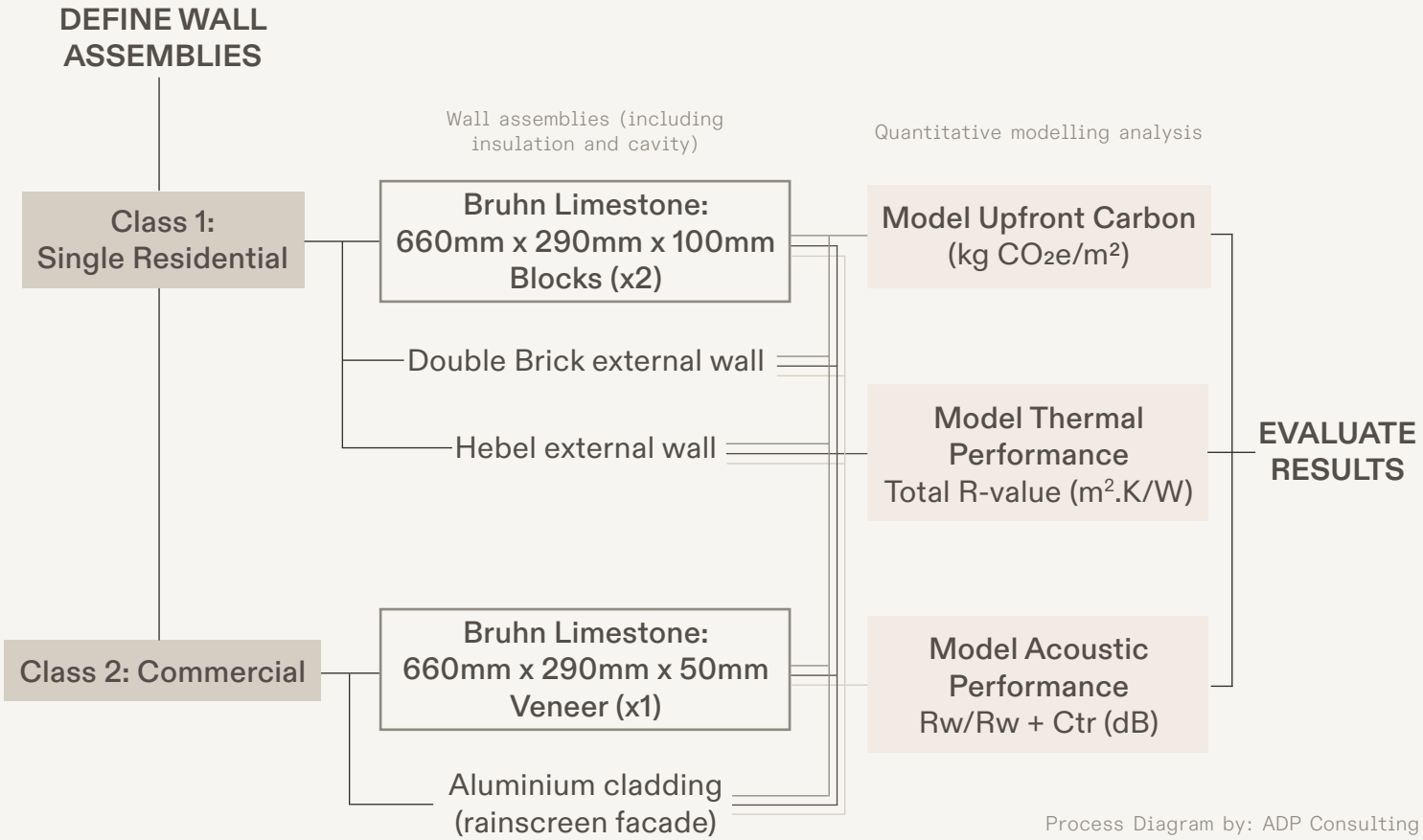
Typical commercial (Class 6) – comparative external wall assemblies evaluated against the Bruhn Mount Gambier Limestone 50 mm limestone veneer cladding system.

Goal & Assessment Boundary

The goal of this study is to **provide insights into the carbon, thermal, and acoustic performance of selected wall assemblies through quantitative modelling analysis.**

The results are intended to benchmark Bruhn Limestone systems against typical wall assemblies currently used in the market, highlighting potential sustainability advantages. In addition, the findings aim to support Bruhn's sustainability positioning by providing evidence-based information that can inform product specification, design decisions, and communication of environmental performance to the market.

The assessment boundary considers representative wall assemblies based on a standardised facade module measuring 1500 mm in width by 2700 mm in height.



Process Diagram by: ADP Consulting

02 Impact Categories

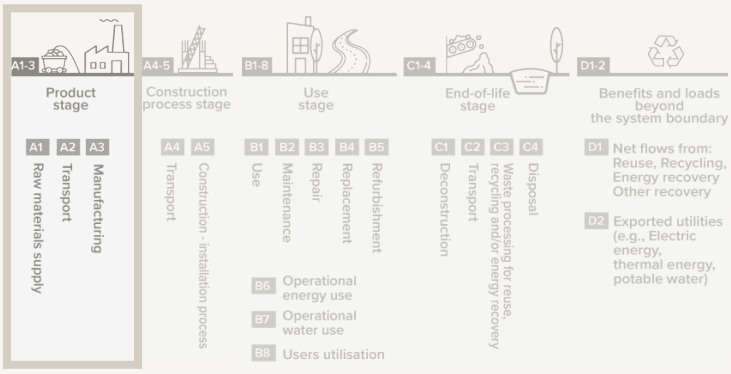
Upfront Carbon

Units: Results of the study will be Global Warming Potential expressed in kg CO_2-e/m^2.
— Lesser values mean less upfront carbon

What is it? Upfront carbon represents the emissions from materials before a building is in operation. The assessment boundary for the assessment includes (Modules A1-A3) as defined in the EN 15978 Standard. ADP uses OneClick LCA software.

Assumptions: OneClick LCA utilises location specific Life Cycle Inventory (LCI) data, incorporating internationally recognised background datasets such as ecoinvent. For this assessment, Australia-specific LCI datasets have been applied where available to ensure regional relevance.

Where product selections are confirmed and product-specific Environmental Product Declarations (EPDs) are available, these have been prioritised and used in the modelling. At the time of assessment, Bruhn Limestone does not have a product-specific EPD. Therefore, a representative Australian natural stone EPD has been adopted as a proxy for the purposes of this analysis.



Embodied Carbon Roadmap ©Infrastructure Australia

Thermal

Units: m^2·K/W.
— Higher values mean better insulation and energy performance

What is it? Thermal resistance (R-value) indicates how effectively a building element resists heat flow. This assessment has been performed in accordance with AS/NZS 4859.2 (2018) - Thermal insulation materials for buildings Part 2: Design which determines the total thermal resistance of insulation products used in thermal calculations using Speckle, now BetterBuildings Software.

Assumptions: Study uses class 1 & 6 buildings, and Sydney is the assumed location for the assessment (Sydney NSW, Australia (33.86°S, 151.21°E) – Climate Zone 5.

Acoustic

Units: Expressed as a single number in dB.
— The higher the value, the better the element performs in reducing airborne sound transmission

What is it? TRw (Weighted Sound Reduction Index) describes the airborne sound insulation performance of a building element. Rw + Ctr (Weighted Sound Reduction Index with Spectrum Adaptation Term) adjusts the Rw value to better represent low-frequency-dominated noise, such as road traffic, aircraft, and urban environmental noise.

Assumptions: The Rw and Rw + Ctr values reported in this report are based on predictions made using INSUL acoustic modelling software. Definitive performance values can only be established through laboratory testing of the specific wall constructions.

03 Thermal Compliance

Thermal Compliance for Class 1

NCC 2022 Volume Two –Building Code of Australia
ABCB Housing Provisions 2022
What is it? Where a Deemed-to-Satisfy (DTS) Solution is proposed for a Class 1 residential building, Performance Requirements H6P1 and H6P2 are satisfied by complying with H6D2 in accordance with NCC 2022-Vol 2. For the purposes of this wall building fabric assessment, Performance Requirement H6P1 only has been evaluated.

Performance Requirement H6P1 for the thermal performance of a Class 1 building may be satisfied by either of the following pathways:

Pathway 1 – Energy Rating (NatHERS): Complying with S42C2 using accredited house energy rating software, and S42C4(1) of the ABCB Housing Provisions.

Pathway 2 – Elemental Provisions: Complying with the following parts of the ABCB Housing Provisions:
- Part 13.2 – Building Fabric; and
- Additional requirements as applicable (not applicable to this assessment)

Both pathways have been considered below in the context of the Bruhn Limestone wall construction.

Bruhn limestone properties and input parameters used:
Bruhn's Mt Gambier Limestone Veneer Cladding (100mm). From the Curtin University of Technology thermal conductivity assessment report dated May 2005, ADP obtained the following values:

- Density = 2360 ± 50 kg/m3
- Thermal Conductivity = 0.49 ± 0.04 W/m.K

Key Assumptions:
- The NCC 2022-Vol 2 requirements for Class 1 building wall performance have been reviewed.

  Under Pathway 1, the wall insulation requirement is project-specific and dependent on the overall building configuration, including orientation, glazing, and roof and floor construction. As such, the required insulation level cannot be prescribed as a fixed wall component specification under this pathway and will vary based on project-specific design parameters.
  To future-proof the design and support compliance under either pathway, a robust approach has been adopted by specifying a minimum of R1.0 insulation, thereby achieving improved thermal performance outcomes.

- EPS insulation used for assessment (Thermal Conductivity - 0.040 W/(m.K))
- Wall height assessed in this study is 2700mm
- Solar Absorptance of 0.35–0.50 (Light)

Thermal Compliance for Class 6

NCC 2022 – Section J
What is it? National Construction Code 2022 | Section J4 sets minimum energy efficiency requirements for building classifications (Class 2 common areas, 3,5–9), covering building fabric, glazing, services, and systems to reduce energy use, improve thermal performance, and support sustainable, low-emission building design across Australia.

How it concerns us? Section J4 of the NCC 2022 sets minimum thermal performance for building fabric, including walls (J4D6-Wall & Glazing). Calculating total R-value ensures the wall system meets NCC Thermal performance requirements and decides compliance for construction in Australian climate conditions.

- Wall components of a wall-glazing construction must achieve a minimum Total R-Value of R1.0, where the wall is less than 80% of the area of the wall-glazing construction; or
- Where the wall is 80% or more of the area of the wall-glazing construction, the value specified in Table J4D6a

Climate Zone	Class 2 common area, Class 5, 6, 7, 8 or 9b building or a Class 9a building other than a *ward area*
1	2.4
2	1.4
3	1.4
4	1.4
5	1.4
6	1.4
7	1.4
8	1.4

Climate zone for Sydney and Melbourne

Table J4D6a: NCC 2022 Volume One

Bruhn Limestone properties and input parameters used
Bruhn's Mount Gambier Limestone Veneer Cladding (50mm). From the Curtin University of Technology thermal conductivity assessment report dated May 2005, ADP obtained the following values:

- Density = 2360 ± 50 kg/m3
- Thermal Conductivity = 0.49 ± 0.04 W/m.K

Key Assumptions
- Reflective Vapour Barrier is included
- Glasswool insulation used for assessment (Thermal Conductivity - 0.040 W/(m.K))
- Wall height assessed in this study 2700mm
- Solar Absorptance of 0.35–0.50 (Light)

04 Wall Types Assessed

Residential Class 1

Objective: To compare the Bruhn limestone wall system against typical external wall systems used in Australian residential construction, focusing on upfront carbon, thermal, and acoustic performance.

Double Bruhn Mt Gambier Limestone Wall

(~200 mm + cavity)

- 2 × 660 mm (length) x 290 mm (height) x 100 mm (depth) limestone blocks
- 50 mm cavity with 40 mm EPS insulation

Double Brick External Wall

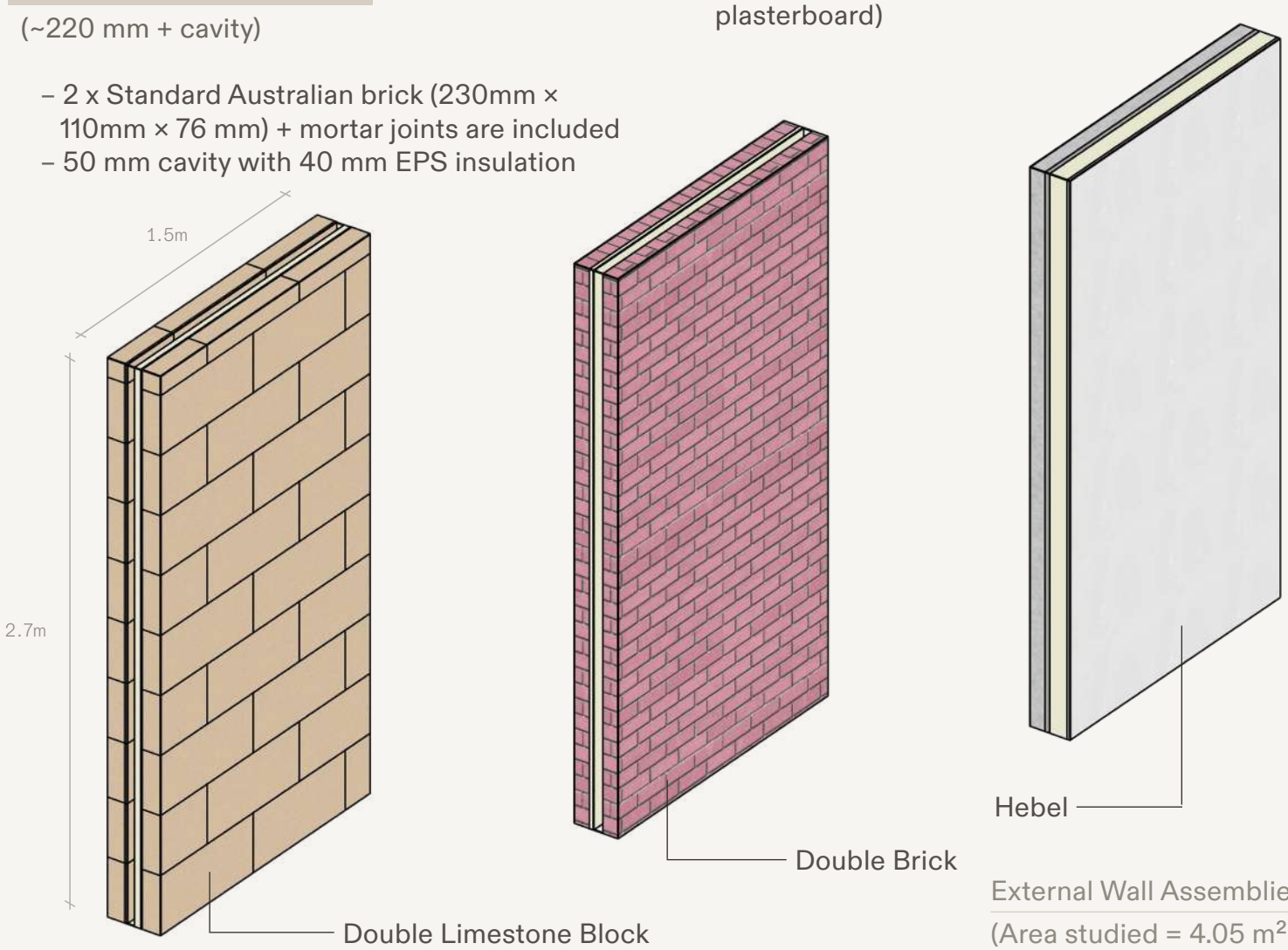
(~220 mm + cavity)

- 2 x Standard Australian brick (230mm × 110mm × 76 mm) + mortar joints are included
- 50 mm cavity with 40 mm EPS insulation

Hebel External Wall

(~75 mm + cavity and insulation)

- Render (paint finish)
- 1 × 75 mm Hebel PowerPanel
- Steel stud frame with 20mm EPS insulation and cavity
- Internal plasterboard lining (13mm plasterboard)



External Wall Assemblies

(Area studied = 4.05 m²)

Disclaimer: Insulation thickness is based on typical thermal performance requirements, including NatHERS assessments and industry experience. Final specifications may vary depending on project-specific design development and site conditions. Standard Australian brick dimensions have been adopted based on typical manufacturer specifications and industry practice aligned with AS 4455 and AS 3700.

Commercial Class 6

Objective: To compare the Bruhn Mt Gambier limestone wall system against typical external wall systems used in Australian commercial construction, focusing on upfront carbon, thermal, and acoustic performance.

Aluminium cladding

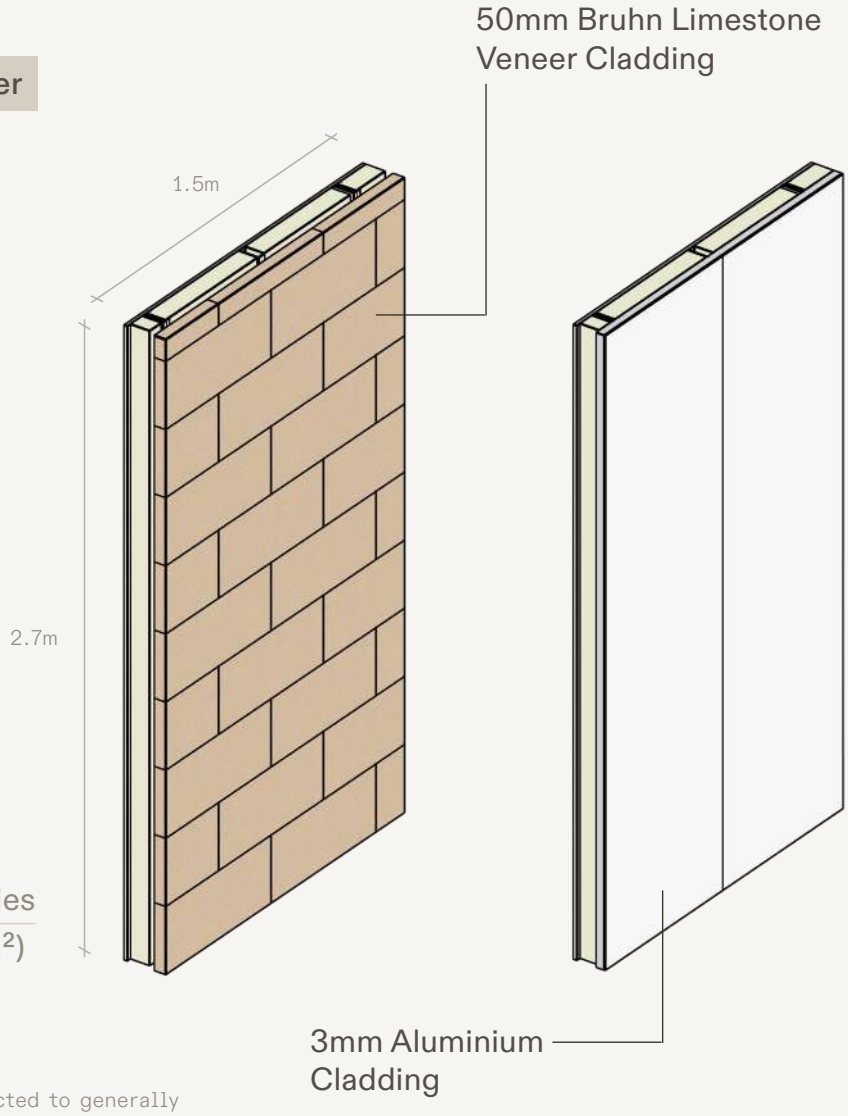
(3 mm + cavity and substructure)

- 3 mm aluminium panel + subframe
- Reflective Vapour Barrier
- Steel stud frame
- 90 mm glasswool insulation
- 13 mm internal plasterboard

Bruhn Mt Gambier Limestone veneer

(50 mm + cavity and substructure)

- 660mm x 290mm x 50mm limestone veneer + subframe
- Reflective Vapour Barrier
- Steel stud frame
- 90 mm glasswool insulation
- 13 mm internal plasterboard

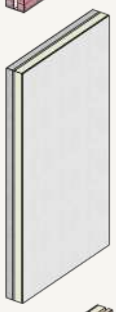


External Wall Assemblies

(Area studied = 4.05 m²)

Disclaimer: Insulation thickness has been selected to generally align with NCC 2022 requirements and typical thermal performance expectations. Final specifications may vary depending on project-specific design development, location, and building typology. The cladding substructure (steel framing) is indicative only and subject to refinement in accordance with project-specific structural engineering requirements.

05 Executive Scorecard

		Upfront Carbon A1-A3 $kgCO_2e/m^2$	Thermal Performance Total R-value ($m^2.K/W$)	Acoustic Performance Rw / Rw + Ctr (dB)
	Residential Class 1 **Double Bruhn Mount Gambier Limestone Wall** (~200 mm + insulation + cavity)	61	1.48	96 / 88
	Residential Class 1 **Double Brick External Wall** (~220 mm + insulation + cavity)	192	1.43	86 / 77
	Residential Class 1 **Hebel External Wall** (~75 mm + insulation + cavity + plasterboard)	65	1.42	48 / 41
	Commercial Class 6 **Bruhn Mount Gambier Limestone veneer** (50 mm + cavity + substructure + insulation + plasterboard)	94	2.66	55 / 50
	Commercial Class 6 **Aluminium cladding** (3 mm + cavity and substructure + insulation + plasterboard)	252	1.68	43 / 31

Disclaimer: The insulation thickness has been included and selected to broadly align with NCC 2022 requirements and typical thermal performance expectations, including NatHERS assessments, based on industry experience. This should be considered indicative only, with final specifications subject to project-specific design development, site conditions, location, and building typology. Class 6 cladding substructure (assumes steel framing) is also indicative and may be refined in accordance with project-specific structural and facade engineering requirements. For full wall build-ups information refer to pages 9 and 10 of this report.

06 Thermal Conductivity

Thermal conductivity (k) is a material property that measures how easily heat flows through a material. Below is a table of key materials that are tested in this report:

Material	Typical thermal conductivity range (W/m·K)	General Performance Comment
Glasswool insulation (or similar)	0.032–0.040	Excellent insulator
Hebel / AAC	0.11–0.16	Strong thermal performer
Bruhn Limestone (Curtin University, 2005)	0.49 ± 0.04 (tested)	Better than typical stone assumptions
Brick	0.6–1.0	Moderate performance
100mm concrete wall	1.4–1.8	Poor thermal performer
3mm aluminium sheet	~160–205	Extremely conductive

Note: Indicative ranges only and highly variable depending on density, moisture, and product type, sources of data come from generic databases, Manufacturer datasheets, CSR Hebel technical manuals + literature, ASHRAE Handbook, CIBSE Guides. Research shows that generic databases often assume k ≈ 1.0–2.0 W/m·K for stone products.

07 Upfront Carbon

As a locally sourced material requiring minimal processing, natural limestone achieves much lower embodied carbon than other conventional facade systems making it a highly efficient low carbon alternative.

Switching to stone products in facades can deliver up to **~60–70% reduction** in upfront carbon across both Class 1 and Class 6 wall assemblies.

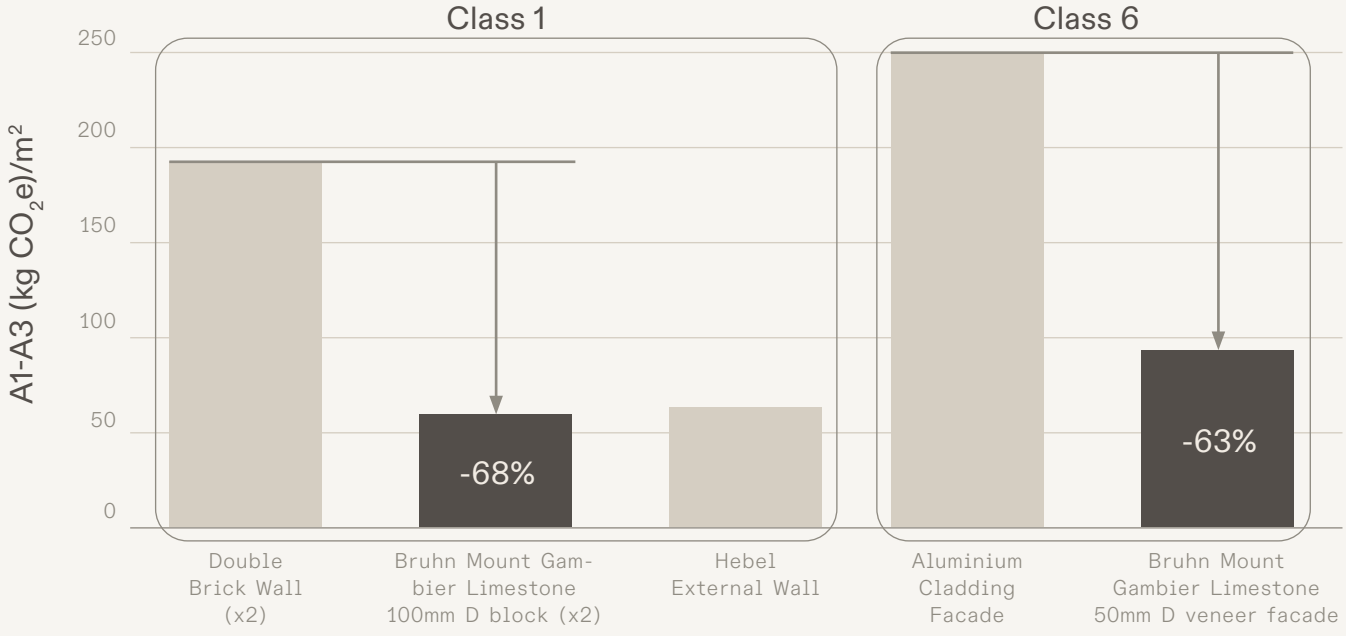
As a locally sourced material requiring minimal processing, limestone lower processing intensity compared to materials such as aluminium making it a highly efficient low-carbon alternative to conventional facade systems.

Key takeouts – Class 1 Wall Types

- Natural Stone significantly outperforms double brick and Hebel systems and positions limestone as a low-carbon alternative to conventional masonry systems.

Key takeouts – Class 6 Wall Types

- Natural stone offers a significant reduction compared to a typical aluminium façade for Class 6 applications. A total of -63% reduction A1-A3 $kgCO_2e/m^2$
- Aluminium façade shows the highest embodied carbon (252 $kgCO_2e/m^2$). Replacing aluminium with stone shows that it provides a large single opportunity for upfront carbon reduction.



Embodied Carbon Comparison of Wall Systems

Bruhn limestone is locally quarried and manufactured in Australia, reducing transport emissions and reliance on imported materials. As a natural, multifunctional material, it minimises the need for additional cladding layers and can be re-used or recycled at end of life.

Summary Results

Class 1 Wall Types		
Wall Assemblies	**A1-A3 (kg CO_2e) full module**	**kgCO_2e/m^2**
Double Bruhn Mount Gambier Limestone Wall (~200 mm D + cavity)	247	61
Double Brick External Wall (~220 mm + cavity)	779	192
Hebel External Wall (~75 mm + cavity and insulation)	263	65

Class 2 Wall Types		
Wall Assemblies	**A1-A3 (kg CO_2e) full module**	**kgCO_2e/m^2**
Bruhn Mount Gambier Limestone veneer (50 mm D + cavity and substructure)	381	94
Aluminium cladding (3 mm + cavity and substructure)	1021	252

Disclaimer: As a product-specific Environmental Product Declaration (EPD) for Bruhn Limestone was not available at the time of assessment, a comparable Australian natural stone EPD (sandstone) has been utilised as a proxy dataset for modelling purposes. For full wall build-ups information refer to pages 9 and 10 of this report

08 Thermal Performance

The 50mm limestone veneer wall construction offers much better thermal properties than conventional facade systems.

The results to follow confirm that limestone can be integrated into NCC-compliant thermal assemblies without compromise.

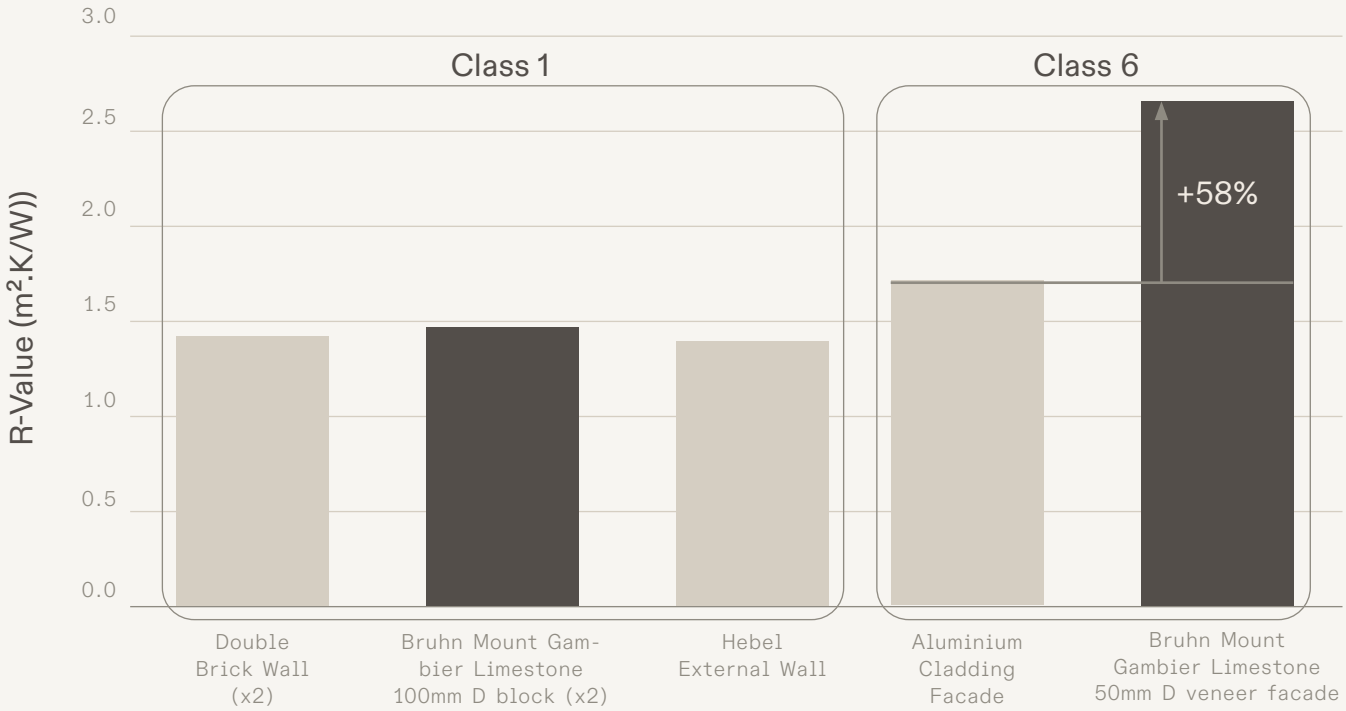
The thermal properties of the limestone were determined using proprietary conductivity and density values from the limestone thermal conductivity report prepared by Curtin University of Technology 2005 dated May 2005.

Key Takeouts – Class 1 Wall Types

- The limestone wall system delivers comparable thermal performance, achieving approximately 3–4% higher R-Values than both double brick and Hebel wall systems.

Key Takeouts – Class 6 Wall Types

- Bruhn Limestone 50mm veneer wall assembly represents a +58% thermal improvement vs aluminium facade.
- The limestone wall system achieves the highest R-value due to its overall build-up including insulation and thermal break.
- Aluminium facade significantly underperforms thermally as is an extremely conductive material.



All Typical Walls Thermal Performance Results

Bruhn limestone provides stable thermal performance as a dense masonry material, offering thermal mass that helps regulate indoor temperatures by absorbing and slowly releasing heat.

Summary Results

Class 1 Wall Types				
Wall Assemblies	**1**	**2**	**3**	**Total**
Double Bruhn Mount Gambier Limestone Wall (~200 mm + cavity)	(R0.11) [2] Bruhn Limestone	(R1.04) Bridged Air Cavity + Insulation	(R0.33)[2] Bruhn Limestone	R1.48
Double Brick External Wall (~220 mm + cavity)	(R0.09)[2] Brick	(R1.04) Bridged Air Cavity + Insulation	(R0.3)[2] Brick	R1.43
Hebel External Wall (~75 mm + cavity and insulation)	(R0.6) Hebel + Finish	(R0.62) Bridged Air Cavity + Insulation	(R0.20) Plasterboard	R1.42

Class 2 Wall Types				
Wall Assemblies	**1**	**2**	**3**	**Total**
Bruhn Mount Gambier Limestone veneer (50 mm + cavity and substructure)	(R0.14) Bruhn Limestone	(R2.33) Bridged Air Cavity + Insulation	(R0.19) Plasterboard	R2.66
Aluminium cladding (3 mm + cavity and substructure)	(R0.04) Aluminium	(R1.45) Bridged Air Cavity + Insulation	(R0.19) Plasterboard	R1.68

Disclaimer:
1. Values are rounded to 2 significant figures.
2. Lower R-value due to semi-ventilated cavity; weep holes allow limited air movement, reducing thermal resistance.

For full wall build-ups information refer to pages 9 and 10 of this report.

09 Acoustic Performance

Limestone systems deliver the highest acoustic performance and consistently outperforms all lightweight facade systems

The limestone wall system delivers a step-change in acoustic performance and represents a significant increase in sound insulation performance.

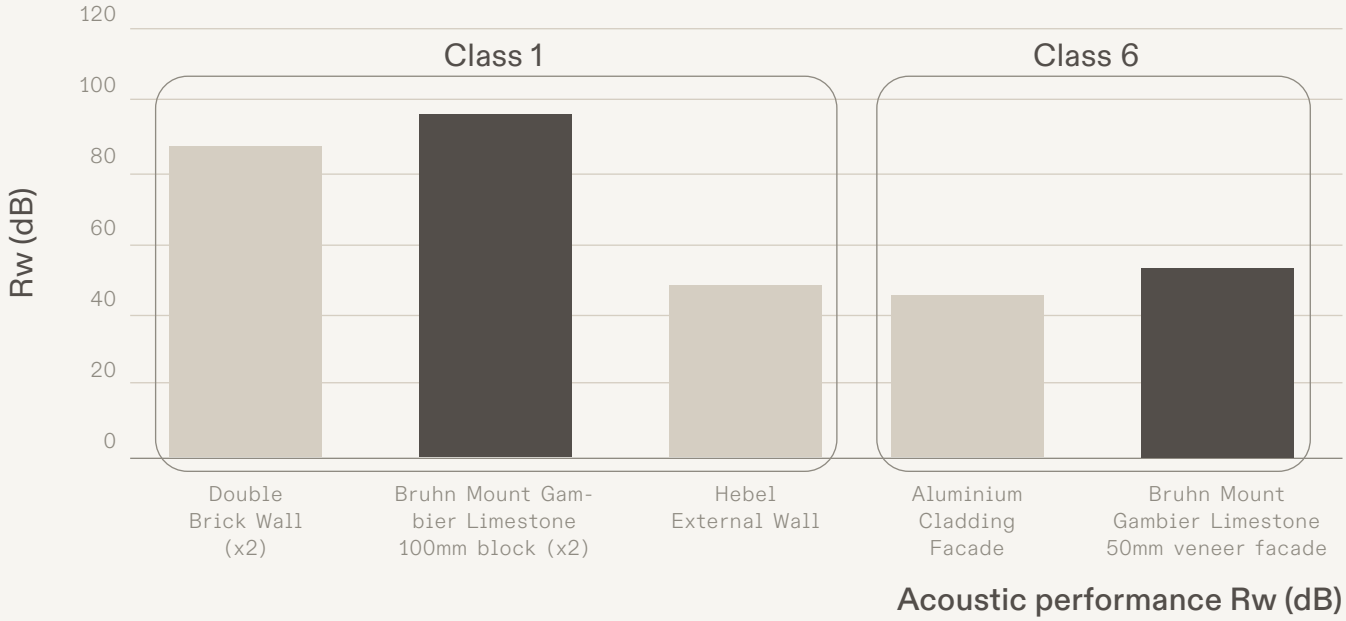
This section presents the predicted sound insulation performance of five wall construction types, expressed as Rw and Rw + Ctr dB. The results are based on specific acoustic modelling and represent estimated laboratory performance.

Key Takeouts – Class 1 Wall Types

- The Double Limestone (100mm block) achieves the best results overall - Heavier, denser systems show significantly higher acoustic insulation.
- Compared with a typical Hebel external wall system, the double limestone wall system achieves more than 40 dB higher sound insulation performance (Rw).
- Compared with a typical double-brick external wall system, the double limestone wall system provides approximately 10 dB greater acoustic performance

Key Takeouts – Class 6 Wall Types

- The Limestone veneer wall system outperform the typical modelled aluminium external wall systems by approximately 12 dB in sound insulation performance.
- The Limestone veneer is better suited to external noise control, particularly for environments influenced by road traffic in dense urban settings.



Limestone-based wall systems deliver superior acoustic performance due to their high mass, significantly outperforming lightweight facade systems such as Hebel and aluminium rainscreens

Summary Results

Class 1 Wall Types		
Wall Assemblies	Acoustic performance R_w (dB)	Acoustic performance $R_w + C_{tr}$ (dB)
Double Bruhn Mount Gambier Limestone Wall (~200 mm + cavity)	96	88
Double Brick External Wall (~220 mm + cavity)	86	77
Hebel External Wall (~75 mm + cavity and insulation)	48	41

Class 2 Wall Types		
Wall Assemblies	Acoustic performance R_w (dB)	Acoustic performance $R_w + C_{tr}$ (dB)
Bruhn Mount Gambier Limestone veneer (50 mm + cavity and substructure)	55	50
Aluminium cladding (3 mm + cavity and substructure)	43	31

Note: As a general guide, for residential development, external walls with an Rw +Ctr of 40 dB or more is considered appropriate for noise environments influenced by traffic, urban hum, or aircraft noise. Higher Rw values are not always required, particularly for sites located in low-noise environments. For commercial developments, external wall sound insulation requirements are generally less stringent than for residential buildings as internal noise criteria for commercial occupancies are less strict. The final selection of wall construction should be based on a project-specific acoustic assessment.

For full wall build-ups information refer to pages 9 and 10 of this report

10 Conclusions

Bruhn limestone can be considered a high-performance, low-impact facade solution delivering superior acoustic performance. Bruhn limestone systems demonstrate a compelling combination of performance and sustainability, delivering:

Superior Acoustic Insulation

Bruhn limestone systems consistently demonstrate superior acoustic performance compared to lightweight and conventional alternatives:

- Up to 48 dB better Rw compared with Hebel external wall systems.
- Up to 10 dB better Rw performance compared with a double-brick construction.
- High resilience to low-frequency noise (Rw + Ctr), making the system particularly suited to urban environments

These outcomes reflect the fundamental advantage of high-mass construction, enabling a step-change in sound insulation performance.

Low carbon material choice

Bruhn limestone is a locally sourced, low processing material that reduces transport impacts and dependency on imports. Its inherent durability and multi-functionality minimise additional façade layers and support circular outcomes through reuse or recycling.

Stone systems achieve significantly lower upfront carbon than aluminium facade systems in class 6 applications.

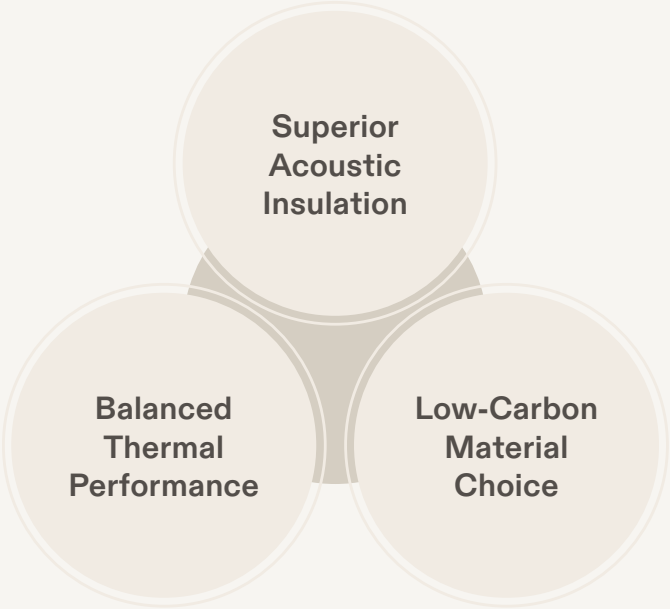
In Class 1 the results show that stone products performs substantially better than double brick (~68% lower). Stone also can be comparable to Hebel systems. This can position Bruhn limestone as a low-carbon alternative to both traditional masonry and high-impact facade systems.

Balanced thermal performance

Limestone wall systems achieve R-values comparable to other conventional wall types, demonstrating their suitability for energy-efficient design.

- Bruhn Mt Gambier Limestone veneer performs up to 58% better compared with Aluminium Cladding wall system.
- Double Bruhn Mt Gambier Limestone Wall provides comparable thermal properties when compared with the Hebel external wall and double-brick construction.

Thermal performance is primarily influenced by the overall wall assembly (including insulation, cavity design, and internal linings) rather than the cladding material alone. This confirms that limestone can be effectively integrated into NCC-compliant wall systems without compromising thermal efficiency.



11 Recommendations

What the data means for your next project.

Specify for superior acoustic performance.

– Delivers a step-change in sound insulation over aluminium and lightweight facade systems
– Up to 48 dB better than Hebel and 10 dB better than double brick
– The material of choice for residential, hospitality, education and noise-sensitive environments

A lower-carbon facade choice.

– Significantly lower embodied carbon than aluminium cladding (63% reduction)
– Substantially lower than double brick (68% reduction)
– A straightforward specification win for projects with a carbon budget or Green Star target

Designed to meet sustainability benchmarks.

– Aligned with Green Star Buildings criteria across Upfront Carbon, Responsible Finishes and Acoustic Comfort credits
– Market-ready for commercial projects with formal sustainability requirements
– Supports NABERS and OneClick LCA integration

A complete wall system.

— Combines with standard insulation to deliver thermal mass, acoustic performance and NCC compliance
— Reduces the need for additional facade systems or materials
— Confirmed compliant with NCC 2022 thermal requirements for both Class 1 and Class 6

Confident budgeting.

— Cost-benefit comparisons against equivalent facade systems available on request
— Supports inclusion at budget and tender stage with confidence
— Benchmarked against aluminium cladding, double brick and Hebel systems

Environmental Product Declaration

— Product-specific EPD currently in development
— Comparable Australian natural stone data available in the interim
— Supports project LCA and carbon reporting requirements

BRUHN

A LEGACY IN LIMESTONE.

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