NTN 008.1

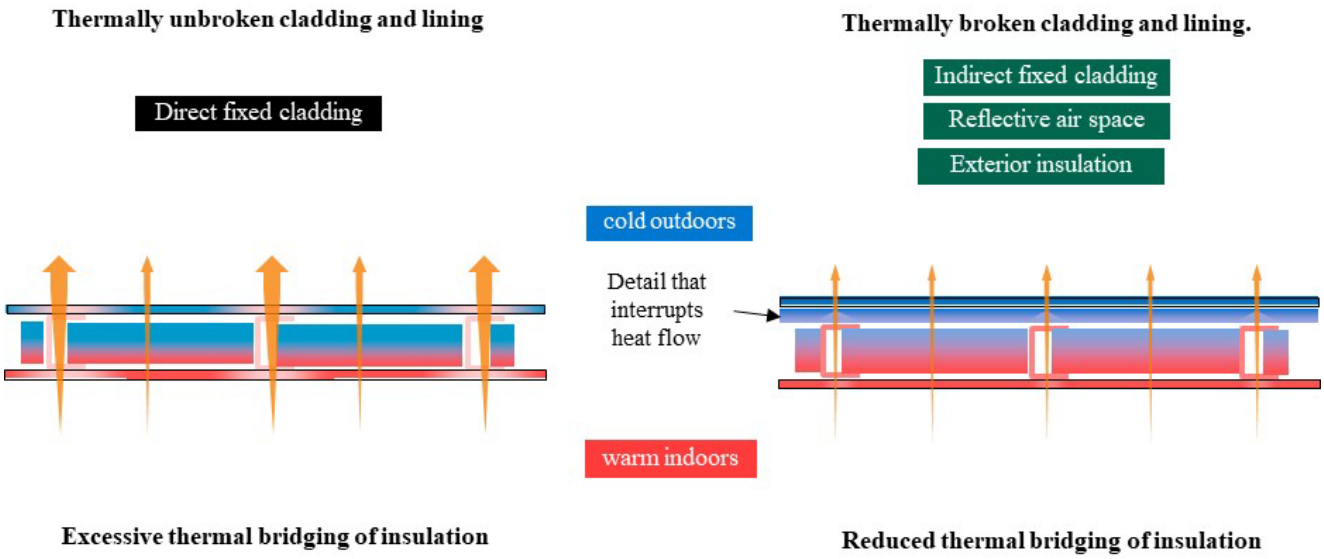
NASH TECHNICAL NOTE

Building Envelope – Thermal Bridging

Detail matters when it comes to thermal bridging and thermal performance.

When a building element contains framing members with lower thermal resistance that pass through surrounding materials such as insulation, more heat is conducted through these members. This effect is referred to as “thermal bridging”, and it can reduce the thermal performance of the insulation layer. Commonly used structural frames of timber and steel both exhibit thermal bridging, the effect being more pronounced with steel framing.

Thermal bridging should be addressed by interrupting the heat flow path through thermal bridges. For steel framing this can range from minimum thermal breaks, indirect fixing of the cladding that can create an air gap, or a reflective air gap, inclusion of blanket and foil to an external insulation layer, including cladding that has inherent insulation, such as externally insulated and finish system or sandwich panels.



Note: The thermal resistance of insulation can also be significantly impacted by heat that may thermally bypass insulation through gaps and air movement.

NCC 2022 regulates how thermal bridging in framed construction must be considered. Typically, compliance is achieved using Energy Rating Software or DTS Elemental Provisions. Each method includes consideration of thermal bridging when steel framed construction is selected.

Energy Rating Software (NatHERS): Appropriate construction details are entered in accordance with NatHERS guidance publications to achieve the minimum required star rating.

DTS Elemental Provisions: The ABCB Housing Provisions Standard can be used to develop specifications for each external building element, with appropriate adjustments to mitigate thermal bridging where and if required. Using this method, there is scope to either make prescribed adjustments or adjustments to each building element to meet prescribed total R-values. NASH Technical Note 6 provides a range of compliant solutions that can be used to speed up this design path.

Building Envelope Technical Note series

This Technical note forms part of a series of notes discussing various aspects relating to the building envelope.

NTN 008.2

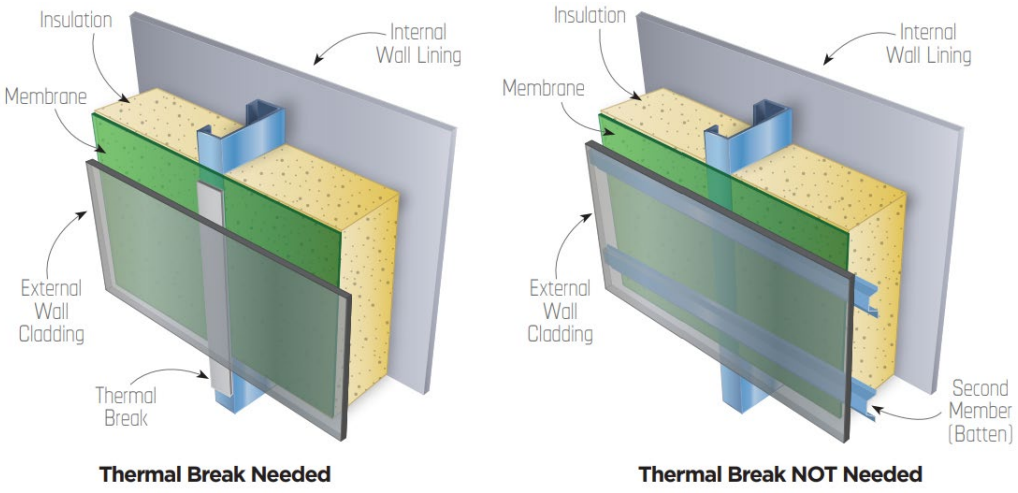
NASH TECHNICAL NOTE

Building Envelope – Thermal Breaks

The NCC requires a minimum thermal break where lightweight cladding and internal lining are both directly fixed to the same steel framing member.

A thermal break is only required in specific situations to meet the energy-efficiency provisions of the NCC.

A thermal break with a minimum R-value of 0.2 is required when both lightweight external cladding (such as steel or fibre-cement) and the internal lining (typically plasterboard) are directly fixed to the same steel member, such as a stud or rafter, or where the building is unlined. This requirement applies to both wall and roof construction in residential buildings.



Source: ASI_NASH-Energy-Efficiency-Steel-Framing-FINAL.pdf

Indirectly fixing of cladding or internal lining—using secondary members such as cladding battens or ceiling battens of any material—removes the need for a thermal break. By separating the cladding or internal lining from the primary steel framing, indirect fixing reduces direct contact and introduces an air space with limited point connections. This approach typically provides better thermal performance than minimum thermal break strips and may be further enhanced when combined with a reflective membrane, as demonstrated in hot box testing reported in UOW SBRC research.

Where thermal breaks are required, they are available as either proprietary strip products or continuous layers. Any material achieving R0.2 may be used, including common blanket-and-foil products installed beneath metal roofing. For lightweight claddings, expanded polystyrene of minimum 12 mm thickness and timber of minimum 20 mm thickness are deemed to meet the minimum thermal break requirement.

Thermal breaks are not required where the external cladding itself achieves an R-value greater than 0.2, such as externally insulated façade systems or insulated sandwich panels.

Explanatory information

- A lightweight wall has no high thermal mass cladding on the outside or lining on the inside. Typically, this would represent a framed wall, clad externally with timber weatherboards, fibre-cement sheet, metal or autoclaved aerated concrete.
- Because of the high thermal conductance of metal, a thermal break is needed when a metal framing member directly connects the external cladding to the internal lining or the internal environment. For the purposes of 13.2.5(5)(b), expanded polystyrene strips greater than or equal to 12 mm thickness and timber greater than or equal to 20 mm thickness are deemed to achieve an *R-Value* greater than or equal to 0.2.

Source: NCC 2022: Housing Provisions Part 13.2.5 Explanatory Information

Building Envelope Technical Note series

This NASH Technical Note forms part of a series of notes discussing various aspects relating to the building envelope.

NTN 008.3

NASH TECHNICAL NOTE

Building Envelope – Thermal Bridging Versus Thermal Breaks

Thermal breaks are one of many ways to reduce thermal bridging in steel framed construction.

Thermal bridging occurs when heat flows more readily through framing materials than through surrounding insulation. Thermal breaks, when required by the NCC, provide one way of reducing this effect – but they are only needed in specific construction situations.

Thermal bridging

Thermal bridging occurs where framing members pass through surrounding materials with higher thermal resistance such as insulation. The framing members provide an efficient path for heat flow, reducing the overall thermal performance of the wall or roof assembly. Both timber and steel framing exhibit thermal bridging; however, the effect is more pronounced in steel due to its higher thermal conductivity.

Thermal bridging can be reduced by interrupting or slowing the heat flow through the frame.

Many construction details inherently reduce thermal bridging, including indirect fixing systems that create an air gap, reflective air spaces, blanket-and-foil combinations, external insulation layers, and claddings with inherent insulating properties such as externally insulated façade systems or insulated sandwich panels.

Thermal breaks

A *thermal break* - as defined in the NCC - is a material with a minimum R-value of 0.2, provided at all points of contact between the metal frame and external cladding. It typical takes the form of a strip or as a continuous layer.

Because a wide range of construction details reduce thermal bridging, the NCC limits the mandatory use of *thermal breaks* - as defined in the NCC - to specific scenarios, where the construction does not inherently reduce thermal bridging described below.

When thermal breaks are required

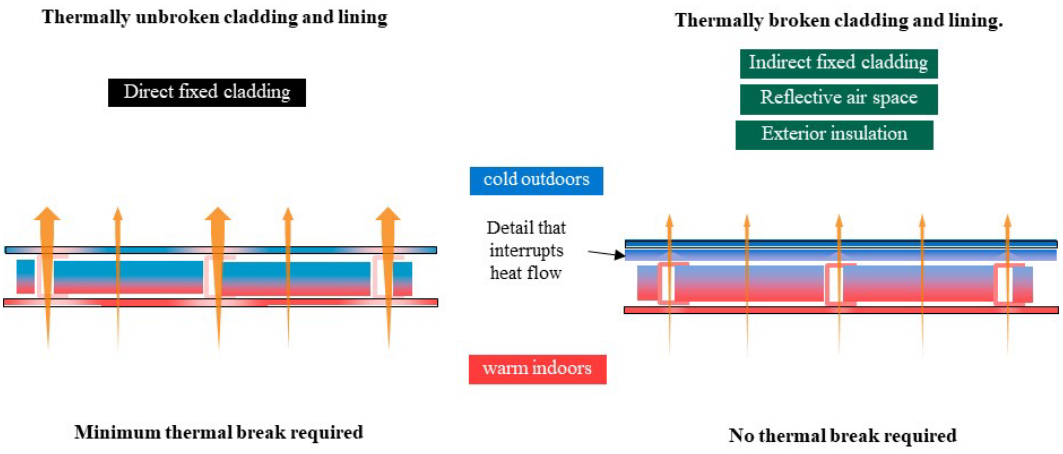
A thermal break is required when:

- lightweight cladding (such as steel or fibre-cement), and the internal lining are both directly fixed to the same framing member (e.g., stud or rafter), or
- the building is unlined

When thermal breaks are not required

A thermal break is not required when:

- cladding is indirectly fixed, such as on battens
- the construction includes an inherent air space, such as in brick veneer systems
- the external cladding has an R-value greater than 0.2, including insulated sandwich panels, or externally insulated systems



Building Envelope Technical Note series

This NASH Technical Note forms part of a series of notes discussing various aspects relating to the building envelope.

NTN 008.4

NASH TECHNICAL NOTE

Building Envelope – Battening Out Lightweight Cladding

Battening out lightweight cladding can help improve energy efficiency, moisture management, indoor health and overall building durability.

Installing battens behind lightweight cladding creates a cavity that reduces thermal bridging, supports effective moisture control, and enhances the performance and longevity of steel-framed building systems.

Battening out lightweight cladding introduces an air gap between the outer cladding and the steel frame, delivering multiple benefits to the building envelope.

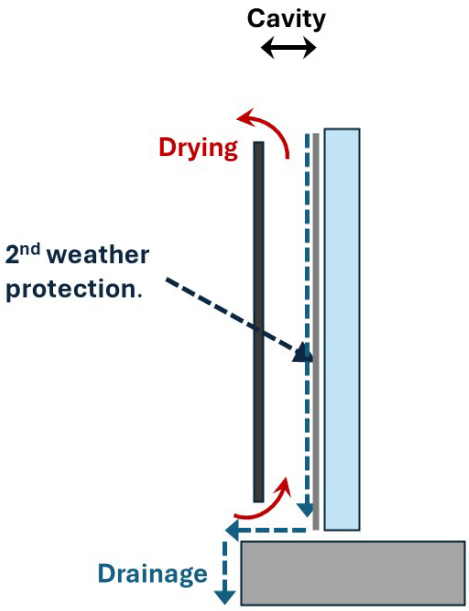
- **Improved energy efficiency**
  The air cavity created by battens interrupts the heat flow path between the cladding and the steel frame, reducing thermal bridging and improving the overall thermal performance of the wall system. Performance is further enhanced when the cavity is combined with a reflective membrane.

  Consequently, a thermal break is not required by the NCC when the external cladding is battened out (indirectly fixed), irrespective of batten material. Hot-box testing of steel frame systems conducted by the University of Wollongong SBRC supports this pragmatic approach. The testing found that the battened-out steel clad walls using steel battens outperformed the direct fixed metal clad wall using minimum-compliance thermal break strips.

- **Reduced condensation risk on frame and plasterboard**

  By keeping framing and internal linings warmer, battening reduces the potential for condensation to form on steel members or plasterboard.

  In colder climates, direct-fixed cladding can create cooler regions on the plasterboard adjacent the framing that in rare instances can lead to patterned staining (ghosting). This condition may result when indoor conditions are both humid and contain airborne particulates that are attracted to the cooler regions on the plasterboard.



Cavity helps keep wall warmer and drier.

- **Improved moisture management**

  When combined with an appropriate membrane, the cavity formed by battens acts as a secondary weather defence. It provides:

  - a further barrier should rain penetrate.
  - a drainage path that allows any water to escape quickly.
  - ventilation that aids drying and reduces long-term moisture retention.

  This supports a drier building envelope and reduces the risk of hidden moisture accumulation.

- **Enhanced health and durability.**

  Keeping the building envelope drier and framing members warmer helps lower the risk of mould and improves the durability of materials and building systems. This contributes to healthier indoor environments and more resilient construction.

- **Compatibility with multiple cladding systems.**

  Battening provides a consistent, stable fixing surface suitable for a wide variety of lightweight cladding systems, improving installation quality and long-term performance.

Building Envelope Technical Note series

This NASH Technical Note forms part of a series of notes discussing various aspects relating to the building envelope.

NTN 008.5

NASH TECHNICAL NOTE

Building Envelope – Ventilation of Air Spaces

Ventilation of air spaces in roofs and walls can help create durable, energy-efficient steel-framed buildings.

Ventilation of air spaces behind cladding can influence thermal performance, moisture control, and durability in complex and dynamic ways. While most cladding rely on a minimum level of passive ventilation this is often achieved through inherent openings in construction.

Ventilation plays an important role in maintaining thermal comfort and managing moisture within building envelopes. Ventilating air spaces in roofs and walls can help reduce heat build-up, limit condensation risk, and support the long-term durability of steel-framed construction.

Passive roof ventilation helps:

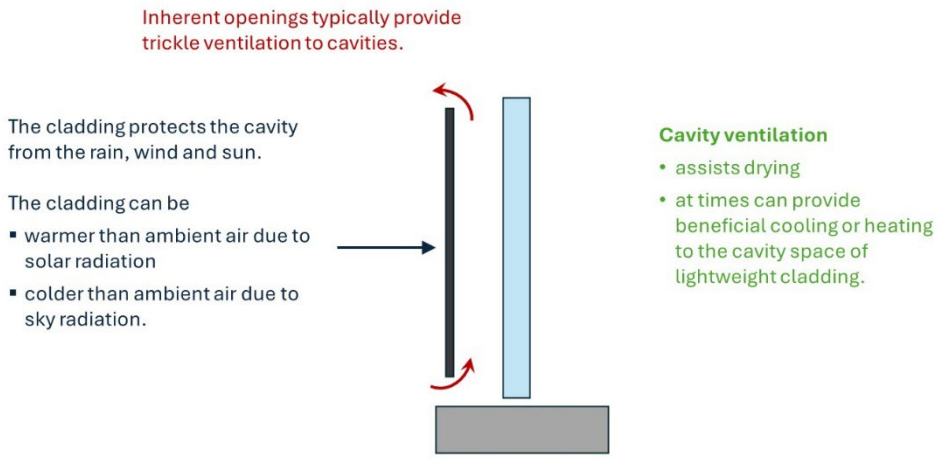
- Remove excess solar heat from roof spaces in summer. Outdoor air replaces significantly hotter roof space air helping reduce cooling loads, particularly where ducted air conditioning is present, and improve thermal performance.
- Removes excess moisture lowering condensation risks. Outdoor air that replaces roof space air typically has lower absolute humidity, particularly in winter when moisture risks are greatest, helping keep the roof space dry.

- Keep the roof space cooler and drier, helping improve the durability of the roof system and components.

Similarly, ventilated cavities behind lightweight cladding can improve durability, thermal performance and moisture management, particularly when combined with reflective membranes.

Adequate ventilation of air spaces behind cladding may be typically achieved through detail that utilises inherent construction openings, such as cladding profile openings and drainage paths. Where additional ventilation openings are required, supplementary ventilation devices may be used, such as ventilation strips and roof ventilators.

The thermal impact of ventilated cavities is highly transient. When cladding is heated by solar radiation or cooled by long-wave sky radiation, cavity ventilation can reduce heat flow into or out of the building, increasing the effective thermal resistance during those periods. Under other conditions—such as when radiation effects are weak—ventilation may reduce the effective thermal resistance by allowing outdoor air to bypass the cladding and exchange heat with materials behind the cavity. The balance between positive and negative thermal impacts is complex and depends upon building element, cladding type and climate. UOW SBRC research indicates that ventilated cavities may improve thermal performance for lightweight low resistance cladding systems, particularly in warmer climates.



Cavity ventilation can be thermally beneficial and assist durability.

For Total R-Value calculations for steel frame construction with brick veneer and lightweight low-resistance cladding it is recommended that air spaces be treated as unventilated for calculation purposes, regardless of whether ventilation is present. While most calculation methodologies, evolved from heating dominated climates, downgrade performance of ventilated cavities, treating brick veneer and lightweight low-resistance cladding in Australian climates is likely conservative and recognises their likely effective higher R-Value and thermal performance summertime benefits.

Ventilation of air spaces is necessary and valuable for buildings. It helps:

- reduce heat build-up in roof and wall cavities,
- lower condensation and mould risk,
- support drying and moisture resilience, and
- support durability and indoor health outcomes.

Building Envelope Technical Note series

This NASH Technical Note forms part of a series of notes discussing various aspects relating to the building envelope.

NTN 008.7

NASH TECHNICAL NOTE

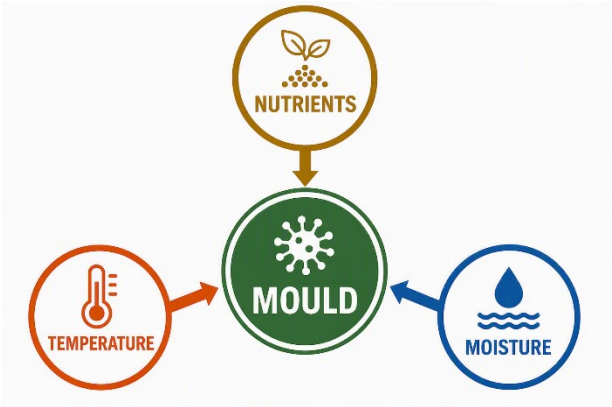
Building Envelope – Steel Framing & Mould Resistance

Steel framing can help create a healthy home with lower mould risk.

Choosing steel framing helps reduce mould risk by limiting sources of nutrient and moisture.

A Mould growth requires three essential components: a nutrient source, moisture, and a suitable temperature range.

Normal temperatures within buildings are generally in the range suitable for mould, meaning that when organic materials and persistent moisture are present, mould may readily develop.



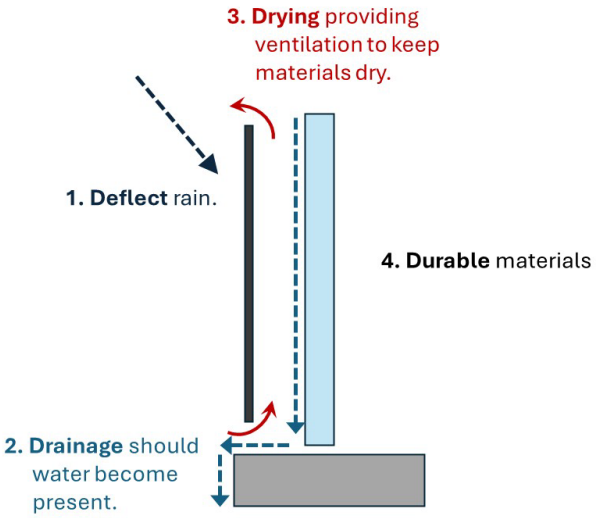
Selecting metallic coated steel framing can help reduce the risk of mould within walls and roof structures by limiting two of these components.

- Metallic coated steel is inorganic so does not provide nutrients required for mould growth.

- Metallic coated steel does not provide or sustain moisture as a source for mould.
    - Steel does not absorb or release moisture
    - Steel does not lock in construction moisture.
    - With appropriate detailing, any water from rain penetration or leaks can drain away without being absorbed into the framing.

Effective moisture management strategies in wall construction include.

- Deflection of rain: use claddings and flashings to keep the rain out.
- Drainage and Drying: ensure any moisture that does enter can escape and dry quickly by including cavities supplemented with building membranes of suitable permeance, refer to NASH Technical Note NTN 9 - NCC 2025 Drained and Ventilated Wall Cavities.
- Durability: select durable robust materials that do not retain moisture and allow water to drain or dry readily.



When combined with good moisture management design, steel framing can help toward creating a healthier, mould resistant home.

Building Envelope Technical Note series

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NTN 008.7

NASH TECHNICAL NOTE

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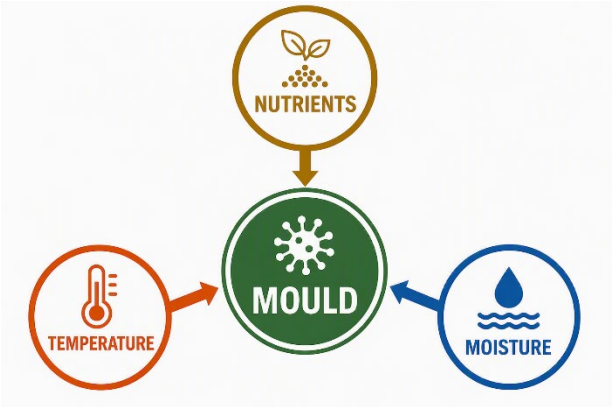

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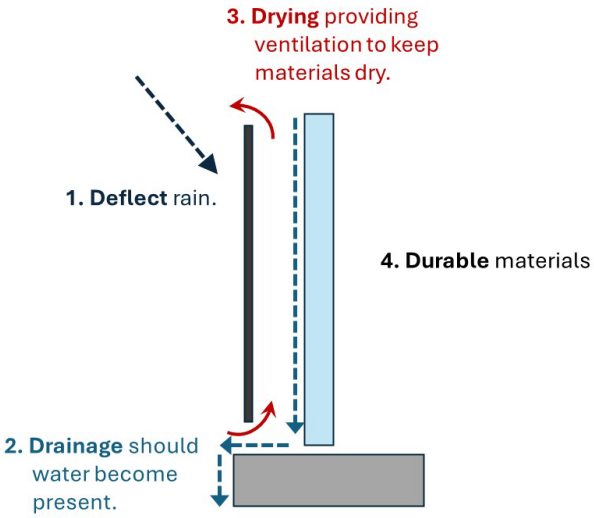

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Building Envelope Technical Note series

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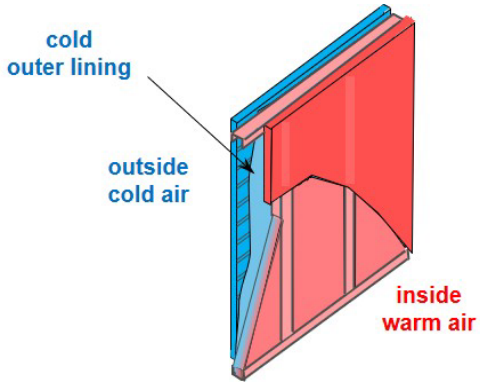
NTN 008.8

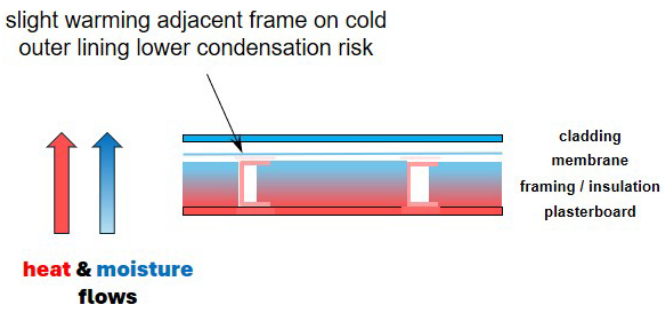
NASH TECHNICAL NOTE

Building Envelope – Thermal Bridging and Mould

Slight warming of the steel frame and cold outer layers from thermal bridging effects help lower the risk of condensation and mould.

Framed construction can be susceptible to thermal bridging effects that can impact on the efficiency of the insulation it bridges; however, the effect can offer some benefit to mitigating moisture and subsequent mould risk in steel framed construction. In cooler climates, the outer layers of insulated wall assemblies are often cold and more susceptible to mould formation from condensation of water vapour. Any thermal bridging caused by framing transfers indoor heat towards the outside causing slight warming in these cold-side layers, lowering mould risk adjacent to the frame.





ABCB commissioned research of typical Australian residential construction demonstrated this behaviour and found that steel framing helps to reduce mould risk near the frame in these cold side locations.

While temperatures inside typical building systems often fall within the range that allows mould to grow, the coldest outer layers of walls or roofs are more prone to high relative humidity or condensation—both key contributors to moisture availability. These higher-risk areas are best managed through good moisture-management strategies that support a healthy, mould-resistant home.

Effective moisture-management strategies include:

Keeping external moisture out: use appropriate claddings, flashings, and detailing to prevent rain ingress.

Maintaining airtightness: ensure internal linings and external membranes are well-fitted to limit uncontrolled air movement.

Allowing moisture to escape: provide drainage paths, promote drying, and use vapour-permeable materials where suitable.

Removing internal moisture sources: exhaust bathroom and kitchen moisture directly outdoors and ventilating indoor spaces to reduce indoor humidity.

Using durable materials: select materials that are robust, do not retain moisture, and promote drainage and drying—such as steel framing.

For additional information refer to Condensation and steel framed homes: Myths vs Facts.

Building Envelope Technical Note series

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NTN 008.9

NASH TECHNICAL NOTE

Building Envelope – Patterned Staining on Plasterboard

Ensuring compliant construction and maintaining a healthy indoor environment minimises the risk of the unusual condition of patterned staining.

Patterned staining is an uncommon condition that may occur on ceilings and walls within the living space when cooler areas of plasterboard attract airborne particulates. Good internal moisture management, adequate ventilation, well-installed insulation and compliant construction practices help minimise the risk of both patterned staining and mould growth.

Patterned staining, sometimes referred to as “ghosting”, appears as faint marks on internal plasterboard that often align with framing members or areas of differing thermal performance behind the lining. The staining occurs when cooler surface areas attract airborne particulates, causing visible patterns to develop over time.

Thermal bypass at gaps around timber frame

Thermal bridging on non-complaint steel frame.

Patterned staining in cold climates due to poor workmanship and/or poor detail.

Patterned staining is more likely in cold climates

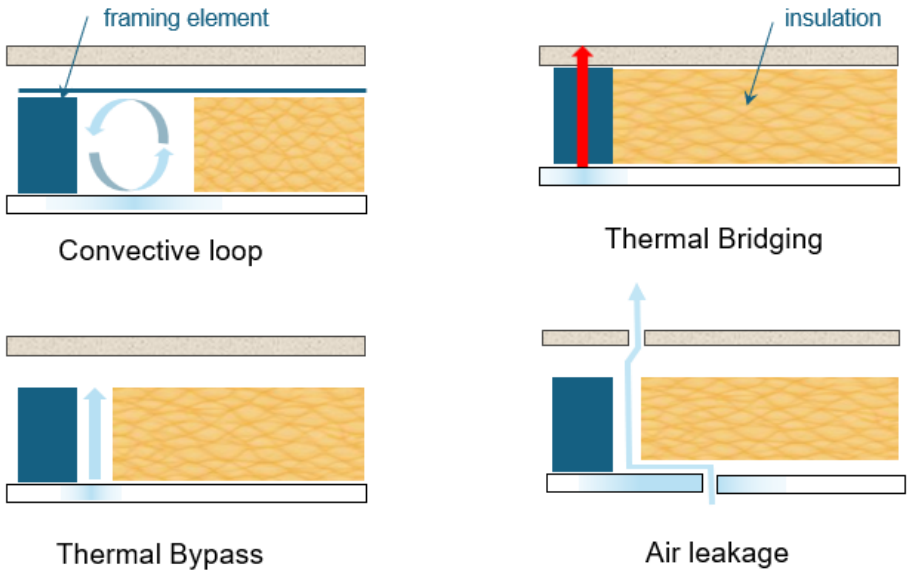
and in homes with certain indoor conditions or construction issues.

Indoor conditions can include;

- High indoor humidity, noting that sustained humidity can also lead to widespread indoor mould.
- Elevated indoor particulate levels from dust, indoor smoking, soot from open fireplaces, unvented combustion heaters and cooking.

Construction issues can include;

- Thermal bypassing, convective looping and possible air leakage from:
  - Gaps or missing insulation.
  - Areas of inadequate insulation.
- Excessive conductive bridging.
  - Steel framing with direct fixed lightweight cladding and lining that does not incorporate the required NCC thermal break may increase the likelihood of patterned staining in cold climates.
- Overly tight construction with a lack of compensating ventilation.
- Absence or poor performance of exhaust systems.



Cooler plasterboard surfaces (shown in blue) may attract airborne particulates resulting in patterned staining over time.

Patterned staining is uncommon in modern residential construction due to improvements in

insulation, ventilation, moisture management, exhaust systems and compliance with contemporary NCC energy-efficiency provisions.

- NCC requires exhaust in bathrooms, kitchens and laundries to discharge internal moisture to the outdoors.
- The NCC requires a minimum thermal break for steel framing with direct fixed lightweight cladding and internal lining.
- Modern appliances keep the air much cleaner, such as air conditioners, that do not produce aerosols and typically include air filtration.
- Unvented combustion heaters, open fireplaces, and smoking indoors have become increasingly uncommon.

Good practices that avoid patterned staining and mould risk within your home include.

- Compliant construction practices.
- Ensuring insulation is well-installed to avoid gaps.
- Regularly ventilating your home and using exhaust fans in bathrooms, laundry and kitchen.
- Avoiding unvented combustion or moisture producing appliances indoors.
- Maintaining general hygiene and cleaning to prevent particulate buildup.

NATIONAL ASSOCIATION OF STEEL-FRAMED HOUSING INC.

Building Envelope TECHNICAL NOTE SERIES

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This publication forms part of the National Association of Steel-framed Housing (NASH)'s Technical Note series, developed to support best practice in steel framed construction and building performance in the wider industry.

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