AUSTRALIAN MODERN BUILDING ALLIANCE
Safe and sustainable construction with polymers

Information Sheet 11:

Energy efficiency provisions in the NCC 2022 and recommendations for NCC 2025

In 2021 the Australian Modern Building Alliance (AMBA) recommended a series of energy efficiency performance recommendations (AMBA Information Sheet 4) for consideration by the Australian Building Codes Board (ABCB) in the development of the National Construction Code (NCC) 2022.

This information sheet provides a summary of the changes to the energy efficiency provisions in the NCC 2022 and AMBA recommendations for the NCC 2025.

Changes to the residential energy efficiency provisions in the NCC 2022

The new residential energy efficiency provisions apply to all Class 1 buildings (houses), Class 2 (sole-occupancy units) and Class 4 parts of buildings (apartments):

- **NatHERS 7 Star Thermal Performance**

  New homes must have a minimum thermal performance level of 7 stars under the Nationwide House Energy Rating Scheme (NatHERS).

  Together with

- **Whole-of-Home Annual Energy Use Budget**

  New homes must also now meet a whole-of-home annual energy "budget" based on the energy used by heating and cooling equipment, hot water systems, lighting and swimming/spa pumps. Renewable energy systems, such as rooftop solar systems, are not mandatory but can be used to offset the actual energy used to achieve the required budget maximum consumption.

In 2021 AMBA recommended that the building envelope performance should never be traded off against onsite renewable energy generation. It is important that this German principle of "*Energiewende or Energy Efficiency First*"[1] as part of a strategy for transition to renewable energy[2] is not diluted. 7 Star thermal envelope must continue to be the minimum requirement.

In addition, there are changes to the following verification methods in the NCC 2022:

- The use of non-NatHERS energy modelling software on the existing Class 1 reference building verification method (H6V2 of Volume 2) has been added,
- A new reference building verification method for Class 2 apartments which is also based on the use of non-NatHERS energy modelling software (J1V5 of Volume 1), and
- Updated deemed-to-satisfy (DTS) provisions to reflect the new 7 stars thermal performance and annual energy use budget changes (Section 13 of the ABCB housing provisions standard 2022 and J2D2(2) and (3) of Volume 1).

Changes to the commercial energy efficiency provisions in the NCC 2022

There have also been changes to the commercial energy efficiency provisions:

- Certain buildings must facilitate future installation of on-site renewables and electric vehicle charging (J1P4 of Volume 1),
- The NABERS Energy Verification Method now covers Class 2 common areas, Class 3 buildings and Class 6 shopping centres (J1V1 of Volume 1),
- There are new DTS provisions to facilitate future installation of electric vehicle charging equipment in carparks for Class 2,3,5,6,7b,8 or 9 buildings (J9D4 of Volume 1), and
- There are new DTS provisions to facilitate the future installation of solar photovoltaics and battery storage (J9D5 of Volume 1).

Changes to the condensation management provisions in the NCC 2022

There have also been changes to the condensation management provisions for roof and external wall assemblies in residential buildings (Class 1, sole occupancy units of Class 2 buildings and Class 4 parts of buildings). Additional guidance is provided in the *ABCB Condensation in Buildings Handbook*[3] to understand the condensation requirements in the NCC to develop *performance solutions* but the advice is generic and not mandatory. The mandatory parts of the NCC are the *performance requirements F8P1 and H4P7* in Volume 1 and 2.

F8P1 and H4P7 condensation and water vapour management

Risks associated with water vapour and condensation must be managed to minimise their impact on the health of occupants.

To minimise condensation risks in the interstitial spaces between the building envelope exterior cladding and the interior lining it is necessary to control:

- liquid water (rain and groundwater) penetrating the building envelope by the use of a water control layer (or drainage plane),
- air leakage through the building envelope by the use of an air barrier. Gaps, cracks and holes in the air barrier allows water vapour to be carried into the building envelope with the air leakage and is 100 times more important than controlling water vapour diffusion through building materials.
- water vapour diffusion through permeable building materials, like fibreglass (FG) batt insulation, with a water vapour control layer, and
- the flow of heat (through the use of insulation) to keep building envelope surfaces above the dew point including control of thermal bridging which can create cold points for condensation.

There are three options to demonstrate compliance with the *performance requirements F8P1* and *H4P7*; a performance solution using *Verification Method F8V1* or *H4V5*, the *DTS Provisions* or an alternative performance solution.

Changes to verification method F8V1 and H4V5

A mould index has been added to the existing Verification Method (F8V1 of Volume 1 and H4V5 of Volume 2) in the NCC 2022 based on an Australian Institute for Refrigeration, Air Conditioning and Heating (AIRAH) document[4]. The methods in this document can be used to complete *hygrothermal calculations* to minimise the potential for moisture damage. Specifically, it must be demonstrated that a roof or external wall assembly has a mould index less than or equal to 3 which means either when visually or microscopically inspected there is less than 10 per cent or 50 per cent coverage of a material respectively with mould.

F8V1 and H4V5 condensation management

(1) Compliance 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 input assumptions in accordance with AIRAH DA07; and the intermediate method for calculating indoor design humidity in Section 4.3.2 of AIRAH DA07".

Note: A water control layer means a pliable building membrane or the exterior cladding when no pliable building membrane is present. A pliable building membrane is a water barrier as classified by AS 4200.1.

Changes to the DTS provisions F8D2 to F8D5 and part 10.8 of the housing provisions

External wall DTS provisions

There are additional DTS provisions for vapour permeance of external wall materials (F8D3 of Volume 1 and Part 10.8.1 in the ABCB Housing Provision Standard 2022):

- **Where pliable building membranes are used the "*pliable building membranes and secondary insulation layers* on the outside of primary insulation in an external wall must be vapour permeable".** Class 4 in climate zones 6 to 8 and Class 3 or 4 in climate zones 4 and 5 because traditional fiberglass (FG) insulation batts are both air and moisture vapour permeable. Unfortunately, this is incompatible with the use of polymer based (vapour impermeable) *continuous insulation* (see below) external to the timber frame and a *temperature strategy* for condensation control (see below) which is commonly used on low energy buildings in Europe and North America when used to augment FG insulation batts within the timber frame. **Further, the requirements for the use of pliable building membranes do not explicitly address the possible need for a vapour barrier VCM in warm humid climates especially when the building is cooled internally with air conditioning (AC).**
- **Where pliable building membranes are not used the primary water control layer must be separated from water sensitive materials by a drained cavity.** Fortunately, this is compatible with the use of polymer based *continuous insulation* (see below) alone external to the timber frame and a *temperature strategy* for condensation control (see below) which is commonly used on low energy buildings in Europe and North America.

F8D3 and 10.8.1 external wall construction
(1) Where a pliable building membrane is installed in an external wall, it must— (a) comply with AS 4200.1; and (b) be installed in accordance with AS 4200.2; and (c) be located on the exterior side of the primary insulation layer of wall assemblies that form the external envelope of a building.
(2) Where a pliable building membrane, sarking-type material or insulation layer is installed on the exterior side of the primary insulation layer of an external wall it must have a vapour permeance of not less than (a) in climate zones 4 and 5, 0.143 μg/N.s; and (b) in climate zones 6, 7 and 8, 1.14 μg/N.s.
(3) Except for single skin masonry and single skin concrete, where a pliable building membrane is not installed in an external wall, the primary water control layer must be separated from water sensitive materials by a drained cavity.

Note: Vapour Control Membrane (VCM) Classification (AS 4200.1:2017)

Class	Category	Vapour Permeance (μg/N.s)
Class 1	Vapour barrier	0.0000 to 0.0022
Class 2		0.0022 to 0.1429
Class 3	Vapour permeable	0.1429 to 1.1403
Class 4		1.1403 and above

So AMBA would recommend the following modification in the NCC 2025 to F8D3 and 10.8.1 be considered by the ABCB.

Suggested modification of "F8D3 and 10.8.1 external wall construction" in the NCC 2025
(1) All porous insulation, with a vapour permeance of greater than 0.143 μg/N.s, installed in an external wall must be accompanied by a pliable building membrane - a) which complies with AS/NZS 4200.1 and b) is installed in accordance with AS 4200.2 and c) is located on the exterior side of the insulation and d) the pliable membrane, sarking type material, must have – a) in climate zone 1,2 and 3 a vapour permeance of no more than 0.002 ug/N.s maybe required, b) in climate zone 4 and 5 a vapour permeance of no less 0.143 ug/N.s and c) in climate zone 6,7 and 8 a vapour permeance of no less 1.14 ug/N.s.
(2) Vapour impermeable board insulation, with a vapour permeance less than 0.002 ug/N.s, does not need to be accompanied by a pliable building membrane provided it is installed as continuous insulation external to the frame in lightweight framed construction or external to the inner leaf in double brick construction.
(3) Except for single skin masonry and single skin concrete, where a pliable building membrane is not installed in an external wall, the primary water control layer must be separated from water sensitive materials by a drained cavity.

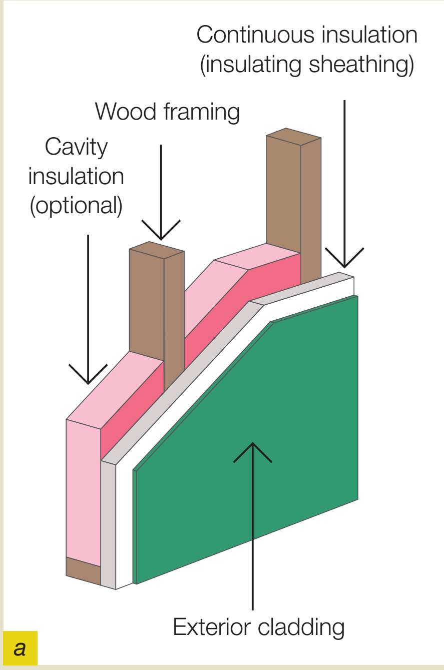
The *continuous insulation* concept is illustrated in figure 1 for a timber frame building and a mass wall system. It has been in use in North America and Europe for many years and uses either polyurethane sprayfoam (SPF) or foil faced polyisocyanurate (PIR) insulation board (figure 2) to provide in a single material thermal (including thermal bridging control), water, air and vapour control. For more information about the *continuous insulation concept* (insulated sheathing) see AMBA Information Sheet 7. For more information on SPF see AMBA Information Sheet 9.

The *continuous insulation concept* complies with the Building Science Corporation's description of the perfect wall; it "has the rainwater control layer, the air control layer, the vapour control layer and the thermal control layer on the exterior of the building structure"[5]. In fact, Lstiburek from the Building Science Corporation has stated that the use of SPF as part of a "clever wall" system[6] "should be the meat and potatoes wall" for commercial buildings[7] using mass wall systems (figure 3) because:

- It maximises the wall thermal resistance by minimising thermal bridging and reducing air leakage which reduces the condensation potential in the wall,
- It negates the need for separate thermal breaks, air-barriers and water resistive barriers, and It simplifies the number of different construction topologies to minimise waste, accelerate installation, reduce workmanship issues and seamlessly connect the thermal, air and moisture resistance barriers.

SPF can also be used to substitute traditional FG batt insulation between studs where it provides in a single material thermal, water, air and vapour control. Further, given the superior thermal conductivity of SPF, compared to FG batt insulation, only 65mm of SPF is required for equivalent thermal performance compared to 90mm of FG batts in a 90mm stud wall so that leaves a 25mm space behind the interior lining[8], as recommended in British Standard BS 5250:2011 + A1:2016, Annex G and the ABCB Condensation in Building Handbook[9], for the installation of services with minimum penetration of the air control layer.

Given that both SPF and foil faced PIR insulation board are both readily available in Australia from a number of suppliers (see text box) there is no reason why the



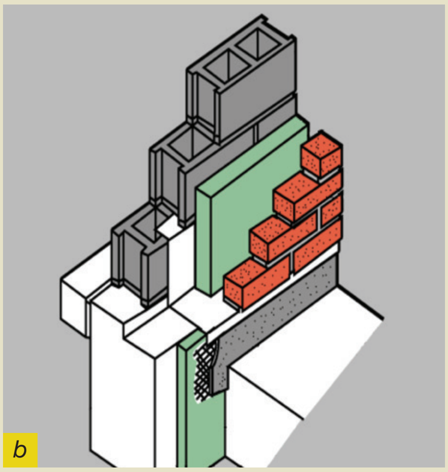


Figure 1: *Schematic Illustration of the continuous insulation concept for a a) timber frame wall, b) mass wall system.*

Figure 2: *a) application of SPF b) foil faced PIR insulation board (photo courtesy of Pirmax Pty Ltd).*

continuous insulation concept including the "clever wall" and SPF as stud cavity insulation should not be included in the DTS provisions of the NCC 2025 in order to encourage the adoption of proven modern insulation techniques in Australia.

Australian polyurethane sprayfoam suppliers include Era Polymers, Pacific Urethanes, and Huntsman Polyurethanes. Australian foil faced PIR board insulation suppliers include Pirmax.

Changes to the exhaust systems DTS provisions

There are also enhanced ventilation requirements for certain rooms such as kitchen, bathroom, sanitary compartment or laundry in the NCC 2022 but will not be discussed in this document.

Changes to the ventilation of roof spaces DTS provisions

There are major changes to the ventilation requirements for roof spaces. F8D5 in Volume 1 and Part 10.8.3 in the ABCB Housing Provisions Standard 2022 dictate the location of sarking and/or primary insulation level, minimum roof space height and the level of adequate ventilation for a roof space to minimise condensation risk. However, F8D5 and Part 10.8.3, as currently written, only requires a vapor permeable sarking (air barrier with a vapour permeance of not less than 1.14 µg/N.s) with porous insulation, such as FG batts, in a cold climate (climate zones 6.7 and 8) external to the FG batt insulation.

Again, it does not explicitly address the need for a possible vapour barrier sarking in warm humid climates especially when the building is cooled internally with air conditioning (AC). Further, F8D5 and Part 10.8.3 fails to explicitly address "ventilated" vs "unventilated" attic solutions as per the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and only discusses two variations of a ventilated roof space, again based around the traditional use of fibrous insulation. An "unventilated attic" solution as per ASHRAE can provide improved energy efficiency compared to a "ventilated attic" solution.

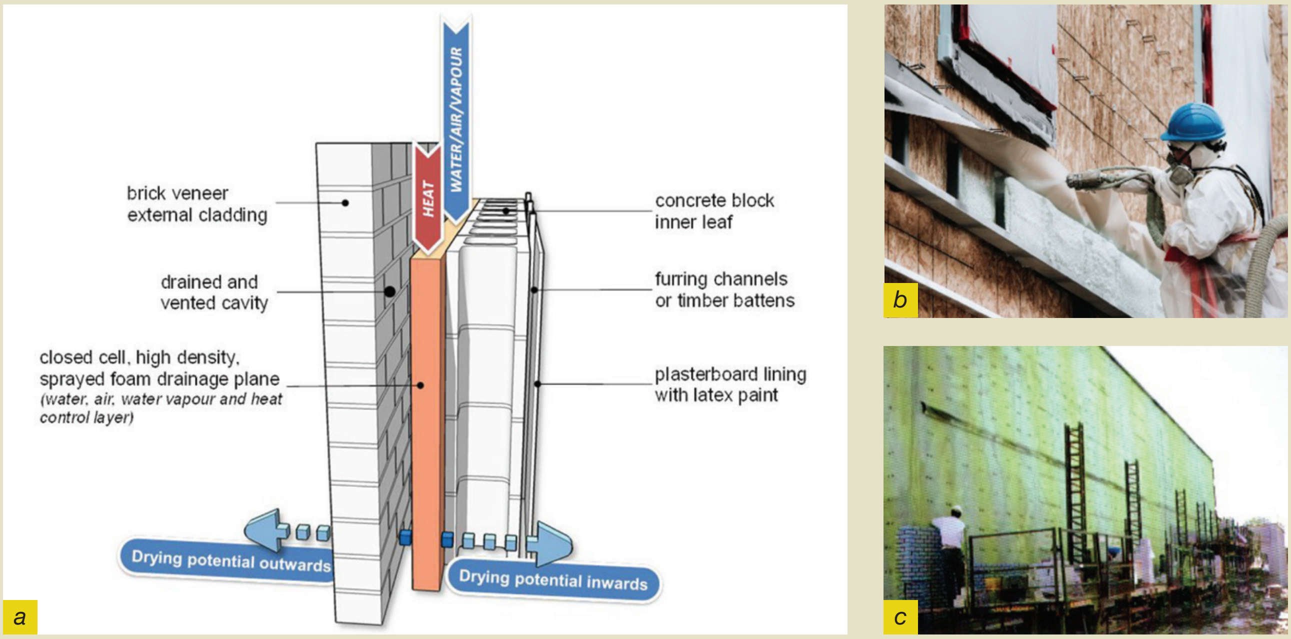


Figure 3: *a) The "Clever Wall" utilising SPF as insulation, water, air and vapour barrier, from The Condensation in Buildings Handbook provided by the Australian Building Codes Board under the CC BY 4.0 licence. b-c) application of SPF.*

F8D5 and 10.8.3 ventilation of roof spaces

(1) In climate zones 6, 7 and 8, a roof must have a roof space that—

(a) is located—

(i) immediately above the primary insulation layer; or

(ii) immediately above sarking with a vapour permeance of not less than 1.14 µg/N.s, which is immediately above the primary insulation layer; or

(iii) immediately above ceiling insulation that meets the requirements of 13.2.3(3) and 13.2.3(4); and

(b) has a height of not less than 20 mm; and

(c) is either—

(i) ventilated to outdoor air through evenly distributed openings in accordance with Table 10.8.3; or

(ii) located immediately underneath the roof tiles of an un-sarked tiled roof.

(2) The requirements of (1) do not apply to a —

(a) concrete roof; or

(b) roof that is made of structural insulated panels; or roof that is subject to Bushfire Attack Level FZ requirements in accordance with AS 3959.

Explanatory information

Part 13.2.3 (3) relates to thermal bridging in metal framed roofs
Part 13.2.3 (4) relates to continuous insulation placed above the primary insulation layer at ceiling level.

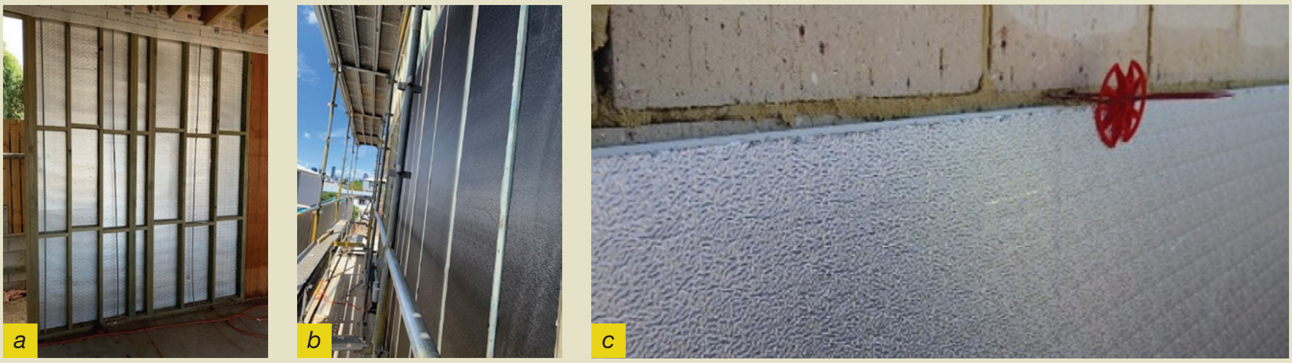


Figure 4: *Foil faced PIR insulation board being installed: a - b) external to a timber frame, and c) to the inner sheath of a double brick cavity wall (photos courtesy of Pirmax Pty Ltd).*

Finally, F8D5(2) and 10.8.3(2) specifically exempt structurally insulated panels to comply with F8D5(1) and 10.8.3(1) and AMBA recommends that the ABCB either explicitly includes foil faced PIR insulation board in this exemption in the NCC 2025 or brings the table into alignment with Part 13.2.3 Roofs and Ceilings which simply refers to *insulated sandwich panels* instead of *structurally insulated sandwich panels*. Either of these changes would allow the use of "unventilated" attic solutions as per ASHRAE which can provide improved energy efficiency compared to a "ventilated attic" solution.

Changes to the provisions for tightly sealed buildings

Additional provisions for tightly sealed buildings have been added into the existing Verification Method (H6V3 in Volume 2 and J1V4 in Volume 1).

The NCC 2022 *permeance strategy* for the control of condensation in buildings has evolved from the traditional use of fiberglass (FG) batt cavity insulation. Yet the implementation to date has been problematic because a 2016 report by the ABCB estimated that 40% of new and existing residential buildings using FG batt cavity insulation – or no insulation at all – across all climate zones were affected by interstitial condensation of water vapour[10] which can adversely impact the energy efficiency and durability of the building, as well as the health of the occupants[11].

The NCC 2022 has failed to fully embrace the alternative *temperature strategy* for the management of condensation in buildings. An approach commonly used in Europe and North America for low energy buildings using the *continuous insulation* concept - polymer based insulated sheathing external to the frame. For further information on the limitations of the *permeance strategy* and the advantages of a *temperature strategy* for condensation control in buildings see AMBA Information Sheet 8.

The NCC 2025 needs a holistic solution to building energy efficiency

Thermal efficiency of buildings, air leakage, thermal bridging and condensation control are inter-connected and require a holistic solution. To further improve energy efficiency in residential buildings there needs to be greater focus on air leakage and thermal bridging where most energy is currently wasted. To this end the pragmatic adoption of prescriptive methods, such as the use of *continuous insulation*, currently used in California to reduce air leakage and thermal bridging is recommended.

H6V3 verification of building envelope sealing

(1) Compliance with H6P1 is verified for building envelope sealing when a building envelope is sealed at an air permeability of not more than 10 $m^3/hr.m^2$ at 50 Pa reference pressure when tested in accordance with AS/NZS ISO 9972 Method 1.

(2) Where an air permeability of not more than 5 $m^3/hr.m^2$ at 50 Pa reference pressure is achieved—

(a) a mechanical ventilation system must be provided that— (i) can be manually overridden; and (ii) provides outdoor air, either— (A) continuously; or (B) intermittently, where the system has controls that enable operation for not less than 25 percent of each 4 hour segment; and (iii) provides a flow rate not less than that achieved with the following formula: where — (A) Q = the required air flow rate (L/s); and (B) A = the total floor area of the building (m^2); and (C) N = the number of bedrooms in the building; and (D) p = the fraction of time within each 4 hour segment that the system is operational; and

(b) any space with a solid-fuel burning combustion appliance must be ventilated with permanent openings directly to outside with a free area of not less than half of the cross-sectional area of the appliance's flue; and

(c) any space with a gas-fuelled combustion appliance must be ventilated in accordance with— (i) clause 6.4 of AS/NZS 5601.1; and (ii) clause 6.4.5 of AS/NZS 5601.1.

(3) For the purposes of (2)(c), the volume of the space is considered to be 1 m^3 for determining ventilation requirements.

Explanatory information

The intent is that 10 $m^3/hr.m^2$ at 50 Pa is broadly equivalent to 10 air changes per hour at 50 Pa when applied to homes. J1V4 is functionally the same as H6V3 for Class 2 (sole-occupancy units) and Class 4 parts of buildings (apartments).

Thermal bridging still not adequately addressed in residential buildings

Eliminating thermal bridging not only improves the thermal performance of the building envelope but is also important in controlling possible condensation problems. Up to 15% of residential energy consumption in the USA is caused by thermal bridging in timber framed houses and an Australian study indicated that ignoring the effects of thermal bridging in timber frame houses is equivalent to the loss of one star in the building NatHERS rating[12]. For more information on thermal bridging see AMBA information sheet 7.

While the NCC 2022 mandates the use of thermal breaks on light weight metal framing even timber frames are an order of magnitude higher in conducting heat than rigid insulation board[13]. Further, the methodology used in NCC 2022 Volume 2 to calculate the R-values of wall assemblies for residential buildings does not allow for the thermal bridging of the timber frame. To remedy this, AMBA recommends that the NCC 2025 Volume 2 for residential buildings adopt the same methodology for the calculation of building element thermal resistance values as in the NCC 2022 Volume 1 for commercial buildings; AS/NZS 4859.2:2018 (which references NZS 4214:2006).

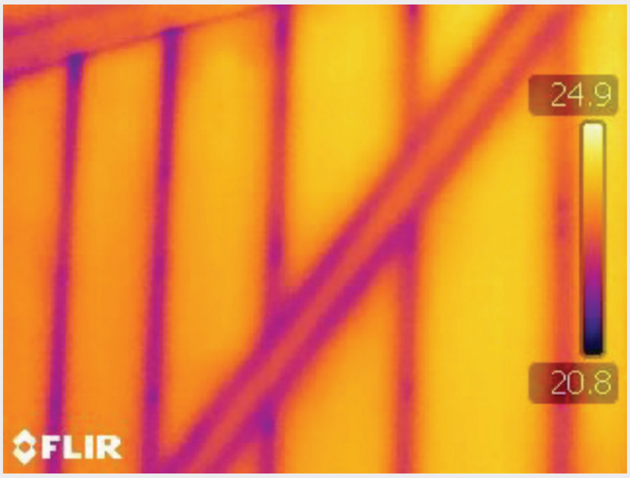


***Figure 5:** Thermal bridging with timber studs (photo courtesy of AUSCAN).*

If the ABCB mandated the use of exterior insulation board, to supplement insulation between wall studs, a proven prescriptive method used by the California Building Energy Standards, it would address ongoing thermal bridging and air leakage problems in Australian buildings (see below).

Building air leakage still not adequately addressed in the NCC 2022

The CSIRO found that over 50% of houses were excessively leaky beyond the assumed airtightness in the NatHERS modelling software[14]. Airtight construction is key in low energy buildings because uncontrolled air leakage:

- can reduce the "as built" NatHERS thermal performance rating of a building by up to 1.7 stars[15]. Further, the CSIRO has reported that the current model in NatHERS for air infiltration underestimates its impact on building energy usage[16], and
- is responsible for the majority (by a factor of up to 100) of moisture movement through building elements, such as a walls, which can cause condensation[17]. Especially when thermal bridges provide a cold surface for condensation.

While the NCC 2022 contains an airtightness target of 10 ACH_{50} AMBA still recommends that the ABCB further investigate a target of 5 ACH_{50} for the NCC 2025 as there are significant energy savings possible because the reduction in energy demand is proportional to the reduction in air infiltration rate[18]. Further, blower door testing (Verification Method JV4 and V2.6.2.3) should be made mandatory to drive improved workmanship of insulation and air barriers.

Conclusion

Building thermal efficiency, air leakage, thermal bridging and condensation control are interconnected and require a holistic solution. To further improve energy efficiency in residential buildings there needs to be greater focus on air leakage and thermal bridging where most energy is currently wasted. To this end:

- the pragmatic adoption of prescriptive methods, such as the use of *continuous insulation* external to the frame or polyurethane sprayfoam between the studs, currently used in California to reduce air leakage and thermal bridging is recommended,
- that mandatory blower door testing be introduced to drive improved workmanship of insulation and air barriers is recommended.

More information:
www.australianmodernbuildingalliance.org.au

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