



Designing better



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Significant performance improvements can be achieved affordably in houses by designing above the New Zealand Building Code minimum requirements. So, where is a good place to start to improve the liveability of a house?

PERFORMANCE requirements set by the New Zealand Building Code are considered comparatively low by international standards.

Going above Code

With many homes currently being designed and built to simply meet the minimum requirements of the Building Code, many opportunities exist to design homes that have much-improved performance. These improvements simply need to be considered at the design stage. While they can add to the cost of the home, many add very little as a proportion of the total cost and will provide significant benefits over the life of the building.

Let's consider some options for going above Building Code within clauses E3 *Internal moisture*, G4 *Ventilation* and H1 *Energy efficiency*. These three clauses relate directly to the important aspect of the health and liveability of a home's indoor environment.

E3 Internal moisture

E3.2, a functional requirement for E3, states that 'Buildings must be constructed to avoid the likelihood of:

- (a) Fungal growth or the accumulation of contaminants on linings and other *building elements*; and
- (b) Free water overflow penetrating to an adjoining *household unit*; and
- (c) Damage to *building elements* being caused by the presence of moisture.'

In most cases, the occurrence of (a) and (c) relates to high levels of internal moisture within a home's indoor environment combined with excessive thermal bridging. Internal moisture generally results



Consideration should be given to extent and orientation of glazing, as well as shading to ensure homes don't overheat during warm months.

in condensation when the warm moisture-laden air meets a cold surface. This can contribute to fungal growth and long-term damage to building elements – particularly wall and ceiling linings and finishes. It also creates an unhealthy indoor environment, with poor indoor air quality having the potential to negatively impact occupants health.

To avoid the potential for this, a home requires a combination of good thermal performance, well-managed internal temperature (particularly during colder months) and effective ventilation.

Simply meeting Code minimum requirements with insulation and ventilation does not guarantee a healthy indoor environment. We often need to go above Code.

Higher-performance homes are insulated well above Code, are very airtight and have effective supplementary heating and ventilation, which means there are unlikely to be any issues with excessive internal moisture and condensation.

Insulation

Insulating the building envelope to levels beyond Code means that the home will be more thermally efficient, maintain a higher and more consistent temperature during cold months for less cost and, if solar gains are managed, keep cooler during warm months.

Higher R-value insulation combined with more thermally efficient exterior joinery and reducing excess framing improves the efficiency of the thermal envelope.

Airtightness

Construction methods and materials used in new homes mean they are generally more airtight than older stock. Air infiltration and exfiltration is reduced, resulting in much lower levels of heat loss.

Various methods of improving airtightness exist. Incorporating a smart vapour retarder behind the interior linings, the use of rigid air

barriers with taped joints or simple techniques like sealing the internal junction of the bottom plate to the floor can further increase airtightness and thermal efficiency.

While having a very airtight envelope aids energy efficiency, it can highlight a lack of effective ventilation. All homes should be well ventilated. What an airtight home gives you is the ability to control the number of air changes per hour to ensure good indoor air quality.

Heating

The World Health Organization (WHO) recommends a minimum temperature of 18°C for occupied spaces. However, the Building Code does not specify how people use homes so generally does not specify minimum heating requirements (except for rest home facilities and early childhood centres).

E3/AS1, the Acceptable Solution for compliance with E3, states that occupants should determine their own methods and levels of heating to prevent indoor moisture problems. For condensation control in the colder months, the internal surface temperature should be maintained above the dewpoint temperature of the internal air by a reasonable margin. This varies with moisture load in the building but, in general, should be around two-thirds of the internal air temperature.

Even with above Code insulation and an airtight exterior envelope, effective supplementary heating will generally be required to maintain temperatures at a suitable level for a healthy indoor environment. See more below under H1 Energy efficiency.

Better ventilation

Although natural ventilation from opening windows and doors satisfies Building Code ventilation requirements, BRANZ research has shown that this is not always an efficient or practical form of ventilation.

A reliable way to achieve the number of air changes per hour required to maintain healthy indoor air quality in a modern home is to incorporate supplementary ventilation.

G4 Ventilation

G4.3.1, a performance requirement for G4, states that 'spaces within buildings shall have means of



Higher R-value insulation combined with reducing excess framing is a cost-effective way of improving the performance of the thermal envelope.



Reduction of thermal bridging will ensure heat loss through external walls is minimised.

ventilation with *outdoor air* that will provide an adequate number of air changes to maintain air purity'.

However, G4/AS1 does not provide any information on the required number of air changes per hour nor what constitutes air purity in homes.

It does state that ventilation of spaces within buildings can be provided by:

- natural ventilation – opening windows and doors with a net openable area of no less than 5% of the floor area of the space being ventilated
- mechanical ventilation
- a combination of both.

G4/AS1 only specifically calls for mechanical extract ventilation as a means of compliance for

spaces in homes containing cooktops, showers and baths.

Meeting the Code minimum requirement with natural ventilation and minimal mechanical extract ventilation does not always mean a healthy indoor environment is achieved. There is a strong dependence on occupant actions that cannot necessarily be relied upon.

The airtightness of many new homes results in infiltration rates of external air as low as 0.05–0.15 air changes per hour (ach), so any dilution offered by infiltration in the past no longer exists.

International guidelines recommend a ventilation rate in the range of 0.35–0.5 ach, diluting and removing contaminants to maintain a healthy environment. While this can be ➤

achieved by opening windows and doors, it is more reliable to go above Code by providing supplementary ventilation to ensure external replacement air is provided.

While supplementary passive ventilation (window sash vents, trickle ventilators and similar) can improve indoor air quality, incorporating supplementary mechanical ventilation will give greater control to ensure enough air changes per hour to achieve significant performance gains.

Mechanical supply and balanced ventilation systems

Supply-only and balanced ventilation systems (usually with heat recovery) are the most common whole-house mechanical ventilation systems. These provide replacement air more effectively, and if properly installed and maintained, they guarantee an acceptable rate of air changes.

Mechanical supply-only ventilation systems take roof space and/or external air and duct it to rooms in the home. It is important that this replacement air is filtered, that the ventilation rate is adjustable and that the system is temperature and humidity controlled.

In mechanical balanced ventilation systems with heat recovery, externally sourced air is filtered and passed through a heat exchanger where it is warmed by the exhaust air extracted from the home. It is then ducted into the home as replacement air. These systems also need to be fully controllable.

Both supply-only and balanced ventilation systems are generally installed in a roof space. In this situation, they perform more efficiently if the ducting and filter, fan and heat exchanger unit is insulated or if the system is located within the external thermal envelope.

Air conditioning

These systems are much less common, as generally they are expensive to install. However, they do offer the advantage of being able to provide cool replacement air during warmer months. With climate change meaning rising temperatures

combined with modern home designs tending to be overglazed and susceptible to overheating, this could become an important above-Code performance consideration.

H1 Energy efficiency

The objective of H1 is to ensure that homes use energy efficiently. Thermal efficiency is a big component of this, and the thermal envelope of a home is an area where significant above-Code performance gains can be achieved. As mentioned, WHO recommends a minimum temperature of 18°C for occupied spaces, but the Building Code cannot ensure people run their houses in this manner. Clause H1 ensures that our homes can be heated adequately in an efficient manner.

Meeting H1 requirements

H1.2(a), a functional requirement for H1, states that buildings must be constructed to achieve an adequate degree of energy efficiency when energy is used for modifying temperature and/or humidity and/or providing ventilation.

A home's thermal envelope is intended to prevent heat transfer from the interior to the exterior in cold months and vice versa in warm months. However, at Code levels, heat loss rates through the thermal envelope are relatively high.

H1.3.1(a), a performance requirement for H1, follows on by stating that the building envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to provide 'adequate thermal resistance'.

The performance requirement H1.3.2E calls for houses to be constructed to ensure that their building performance index (BPI) does not exceed 1.55. The BPI is the heating energy of the building divided by the product of the heating degrees total and the sum of the floor area and the total wall area.

H1/VMI, the Verification Method for demonstrating compliance with H1, calls up NZS 4218:2009 *Thermal insulation – Housing and small buildings* as a means of complying with the insulation performance requirements for

homes. This standard provides three methods for demonstrating compliance – schedule method, calculation method and modelling method which calculate the BPI.

Using the modelling method, such as BRANZ ALF 4.0, provides confirmation of compliance by calculating a home's BPI to confirm it does not exceed the maximum 1.55. It also enables energy efficiency to be optimised at the design stage by evaluating different features such as insulation levels, window and glazing types and building orientation. It can provide options for significantly improving the thermal efficiency of the building envelope and creating above-Code performance.

Think about the glazing

While window and glazing type is important, the extent and location of exterior glazing should also be considered. Even the highest thermal performing external joinery has a considerably lower R-value than the wall in which it is installed. As glazing represents a high proportion of a home's heat loss or gain, too much glazing can lead to significant heat loss during cold months and overheating of the interior during warm months.

Designs should consider limiting west-facing glazing to minimise late afternoon overheating and south-facing glazing to minimise heat loss. Glazing should be concentrated on the north face to maximise heat gain during cold months, with shading of this glazing considered to reduce heat gain during warm months.

The airtightness of the exterior envelope also has an effect on thermal performance. While current forms of construction are capable of creating an airtight envelope, other options such as the inclusion of a smart vapour retarder and bottom plate sealant, as covered earlier under airtightness, can be used to increase efficiency.

Improved thermal performance reduces heating and cooling requirements and costs.

Passive solar design

The techniques of passive solar design offer further opportunity for above-Code performance.

The principles are not new but still form the basis of good residential design. (See *Back to solar design basics* on pages 36–38 for more.)

Consideration of correct orientation of the home relative to sun and wind and the extent and location of exterior glazing are fundamental to good passive design. Shading is also a key consideration as many homes have the potential to overheat during warm months – particularly those with a high proportion of external glazing. This becomes even more important as insulation levels increase and as climate change effects become more pronounced.

Simple passive solar principles can create a home that has more consistent internal temperature

throughout the year and requires less energy to warm or cool and therefore is less costly to run.

Thermal bridges

Heat can escape a home's warm interior to the cold exterior by following the path of least resistance through the thermal envelope. These paths constitute thermal bridges, which are formed by materials that are better at conducting heat than those around them – timber or steel exterior wall framing for example.

Thermal bridges reduce the thermal performance of the envelope. The extent of reduction depends on the area of the bridge and its thermal conductivity. Performance

gains can be achieved by minimising thermal bridges.

Plenty of opportunities to go beyond Code

Significant performance gains in new-build homes can be easily achieved by going above Code. The examples here relate to only three Building Code clauses, but going beyond the minimum for other Code clauses offers even more opportunities for performance gains.

The challenge for the industry is to understand the opportunities, incorporate performance improvements at the design stage and ultimately to normalise above-Code homes. ◀