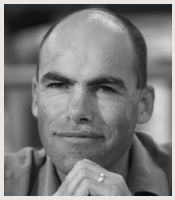

WINDOW FRAME SELECTION

Continuing the glazing series, this article deals with window frames, discussing the effect of timber, aluminium, PVCu and steel frames on thermal and durability issues.

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Timber sashes with 3 or 4 mm thick clear glass panes puttied into them dominated the New Zealand residential window market until the late 1960s. In the early part of the 20th century, glass was hand blown and could not be made in large sheets. This resulted in windows constructed from many small sheets of glass with large numbers of horizontal and vertical elements known as 'muntin bars'.

Larger panes were possible when glass-processing facilities improved after World War II and muntin bars no longer needed to be used. (Muntin bars can now be simulated by enclosing pane separators within IGUs to break up large panes.)

From timber to aluminium

Timber windows were initially constructed from imported timbers, such as western red cedar, or from rimu, totara or other similar local durable timbers, and site glazed. Later, off-site glazing became standard.

Treated radiata pine has generally not been used for window frames since it suffers from poor dimensional stability and durability. However, it is used for the timber reveals of aluminium windows where it is typically finger jointed and treated to H3.1 to resist decay.

Steel windows were commonly used from the late 1920s. They were usually selected when fire rating was an issue, a factory was close by or architects wanted the slim steel frame and glazing bar sections.

Aluminium did not become a significant player in the window industry until the late 1960s. It rapidly gained market share due to its typically lower cost, lower maintenance requirements and suitability for use in production lines. Aluminium framing allowed glazing to be rapidly installed in window frames with aluminium (or initially plastic) beads and vinyl or plastic wedges and seals, rather than glazing putties. It meant windows were all manufactured in factory conditions, which allowed better quality control and process automation.

Aluminium dominates the range

The window/door frame materials currently available in New Zealand include:

- aluminium
- aluminium with internal timber finish
- thermally broken aluminium
- timber (imported cedar is predominant, but other imported timbers and locally sourced *Pinus radiata* are available)
- laminated timber
- PVCu
- steel, stainless steel or galvanised steel.

Over 90% of the domestic window market uses aluminium for frames. This includes a huge variety of aluminium profiles, types and window features, with virtually any colour available through powder-coating technologies.

Different hardware and window control systems are becoming available. European 'tilt and turn' and 'five-point locking' options are available in PVCu, and bifold and stacker systems augment the more common casement and awning windows in aluminium.

The higher thermal performance requirements for windows introduced in 2008 by Building Code clause H1 *Energy efficiency* have meant that double-glazed units in aluminium frames are now the normal specification for homes. This has led to more site glazing, since the added weight of the IGUs and larger window sizes makes transport of completed windows more difficult.

Climate affects life cycle costing

The performance of windows in homes is affected by the frame material and the type of glazing. While aluminium and steel's thermal performance is not as good as timber or PVCu window frames, aluminium has better durability and typically lower capital and maintenance costs. Steel can also be durable when it is fabricated in stainless steel or used outside of sea spray zones and well maintained.

Steel, aluminium, thermally broken aluminium and PVCu all have higher embodied energy than timber (the amount of energy required to produce the material), while steel and aluminium typically have higher operational →

energy costs (the amount of energy used to maintain comfort conditions inside a dwelling). The ability to recycle or reuse materials at the end of their life is also important.

Life cycle costing (LCC) – the financial purchase costs and any on-going maintenance of the product – should also be considered.

Overseas work shows that life cycle costs vary with climate:

- In the extreme climates of Europe and North America, operational energy use is the largest contributor to LCC, therefore windows with good thermal performance have the lowest LCC.
- In some Australian climates, the operational energy of window systems is less significant, so windows with low embodied energy have the lowest LCC.

Table 1 shows the typical performance of the main window materials in New Zealand.

Consider thermal performance and LCC

Unfortunately, full life cycle cost (LCC) information is not available for window systems in the New Zealand environment.

However, research performed by BRANZ for the Department of Building and Housing has shown (without assessing the full life cycle) that the most cost-effective window types for use in all climate zones of New Zealand are aluminium-framed double-glazed units. Some other options have similarly good cost effectiveness in particular climate zones or with specific operation. In this case, advanced glazing systems with low emissivity glass or inert gas fills can be appropriate (see *Build* 123, pages 58–59).

Windows provide the greatest opportunity for thermal improvement of any cladding element in a typical house. While the Building Code establishes the minimum performance requirement for windows, BRANZ recommends that:

- window systems with higher thermal performance are used
- life cycle costs of windows in New Zealand are investigated.

This is the fourth and final article in the glazing series that has been running in Build.

Table 1: Ranking of window performance parameters in New Zealand climate.

Frame type	Embodied energy	Operational energy	Recyclability	Capital cost
Steel	High	High	Excellent	Medium
Aluminium	Very high	High	Excellent	Low
Thermally broken aluminium	Very high	Medium	Moderate	Medium
Timber	Low	Low	Poor	High
PVCu	Medium	Low	Moderate	Medium