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Measuring the Extent of Thermal Bridging in External Timber-Framed Walls In New Zealand

Final Report – Building Levy Project LR11092

Prepared by Beacon Pathway Inc.

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About This Report

Title

Measuring the Extent of Thermal Bridging in External Timber-Framed Walls In New Zealand

Authors and Researchers

Verney Ryan, Guy Penny, Jane Cuming, Ian Mayes, Graeme Baker
Beacon Pathway Inc.

Reference

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1 Executive summary

The case for having a well-insulated house with a minimum of thermal bridges is now well established; there are proven health, energy efficiency, and financial benefits. However, significant housing-related health and energy inefficiency issues persist in New Zealand. The thermal performance of a wall depends, in part, on the content of framing because framing has a significantly lower R-value than the bulk insulation materials typically used in walls of new houses. As framing content increases, wall R-value, as a whole, decreases accordingly.

The Building Research Levy-funded project, **LR11092 Measuring the extent of thermal bridging in external timber-framed walls** assessed a case study sample of 47 new residential houses under construction in New Zealand to determine the as-built framing content and extent of thermal bridging in exterior walls. The aim was to deliver insights into:

- The scale of the issue of high percentages of framing in New Zealand residential construction
- The effect that high percentages of framing has on as-built R-values
- The causes/reasons why high percentages of framing might be occurring.

The research has collected primary data from new builds under construction, including case study houses in the major house construction areas of Auckland and Christchurch, Hamilton and Wellington.

Initial research and informed industry knowledge indicated that Frame and Truss (F&T) manufacturers supply in excess of 90% of the framing to new residential builds in New Zealand[1]. This helped to evolve a major new aspect of the research approach which utilises hard copies of F&T panel elevations and plan layouts on site to assist with data gathering. The team also undertook a series of interviews with major suppliers to industry, cladding manufacturers, and representatives from F&T, which ensured the trust and cooperation of the F&T sector in obtaining framing plans, and has proved crucial to understanding how the design process worked and what drove design decisions.

Final results are based on a survey of **1103 wall panels** (across **71 levels and 47 dwellings**) and indicate the following key aspects:

- The average percentage of framing in walls was 34% (over the net wall area) varying from 24% to 57% (by level).
- Some individual wall panels have very high percentages of framing (50-100%); for example, smaller wall panels that are part of a larger overall wall can have higher percentages of framing - up as high as 70-100% per panel.
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[1] *This figure was provided as an estimate from a number of different F&T manufacturers and representatives from the Frame and Truss Manufacturers Association or FTMA who quoted figures as high as 96% of supply to the residential sector*

- There is little additional framing added on site. Around a quarter of all panels (291/1103) have added full depth framing, with the average for panels with added framing being just under 2% of net wall area, varying between 0.04% and 8% across the case study sample. The average additional site-added, full-depth framing timber by level is just 0.7% (range 0.1 – 4.0%)
- The average percentage by level of un-insulated areas (gaps or spaces in the wall cavity and including additional blocking installed typically for fixing linings, cladding, fixtures and services) was 3% with the lowest being 0.5% and the highest 10% across the sample.

The research also delivered insights across a number of key areas including:

Sector/industry findings

A number of design requirements in regulations have led to increased framing. This includes changes to E2/AS1 requirements for cladding as part of addressing weathertightness, structural requirements of NZS3604, council wind zone requirements, and structural requirements for multi storey buildings. Other factors include: designer preferences e.g. for cladding trends; less than optimal placement of windows in relation to studs during design; and design trends for double height vestibules impacting stud spacing. The research team also noted that F&T design software, which drives the design of panels, does not assess thermal performance, and although it is efficient in not using unnecessary timber, can result in double studs where panels meet. Additionally, the timing of sub-trades can mean walls are not fully insulated, especially at corners and internal wall junctions. These un-insulatable areas appear to be a commonly found and important weakness of the thermal envelope that is not currently considered in H1 calculations.

Regulatory findings

Different aspects of the Building Code appear to have been developed, or updated, without reference to other important features of the Code. For example, cavity construction has resulted in extra framing. Even though NZBC Clause H1 (Energy Efficiency) was amended in 2007 (after development of E2/AS1), it did not appear to take into account the corresponding increase in framing percentages required. Importantly, definitions of construction R-value in NZS 4218, which informs schedule and calculation methods, allows users to exclude a significant percentage of the framing when assessing framed walls, and therefore effectively ignore the real effect of thermal bridging. This means the deemed-to-comply compliance methods set out in H1/AS1 and E3/AS1 may not be achieving the minimum R-values assigned/claimed. This is evidenced by the fact that the average framing percentages of the case study dwellings appear significantly higher than those assumed in R-value calculations used to establish compliance with H1 (Energy Efficiency) and E3 (Internal Moisture). There is an opportunity for the results of this research to contribute to MBIE's Building Code review currently underway.

Findings outside the research brief

The team has noted a number of issues during their site visits, particularly around the lack of insulation in or around external corners, confined stud/nog work, half depth framing, 'high and dry' packers, a lack of insulation around the perimeter of midfloor sections, and the perimeter of concrete slabs. In addition, there were examples of poorly installed insulation and the structural integrity of some framing was compromised due to additional work on site.

The project has raised further questions and indicated areas worthy of further investigation. Additional research would usefully deepen our understanding of the variables contributing to higher or lower percentages of framing identified in the initial phase of this work. Further activity could aim to examine the impacts of these higher framing percentages on resultant R-values as well as describe weak points and blind spots identified in the case study houses which are likely to reduce the thermal performance of walls. Investigations could explore practical and buildable solutions to the identified thermal bridging challenges through examination of advanced framing techniques.

Findings from the current and suggested research have the potential to inform changes to building regulation and the codes governing the design and construction of external walls in New Zealand's residential sector. Given New Zealand has an extensive residential building programme underway that is likely to continue for many decades, it is prudent and smart to ensure new builds are compliant with NZBC requirements for energy efficiency, thermal resistance and moisture management, rather than continue to embed a systemic problem that will incur costs for subsequent generations.