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BULLETIN

BUILDING WITH 140 MM TIMBER EXTERIOR WALL FRAMING

September 2023

- There are many ways to increase thermal performance in external walls – for example, a secondary insulation layer or using materials such as structural insulated panels.
- One way to improve performance is to increase the exterior wall framing depth from 90 mm to 140 mm to accommodate thicker bulk insulation.
- The increase in the total upfront build cost will be offset by reduced operating costs (particularly heating costs) for the building's service life.

1 INTRODUCTION

1.0.1 There are many ways to achieve improved thermal performance in exterior walls. For example, many homes have already been consented and constructed with secondary insulation either on the inside or the outside of the structural wall framing. The BRANZ *House insulation guide* 6th edition specifically covers the options of secondary insulation. Other possibilities include using different types of materials such as structural insulated panels (SIPs), which are also being used in residential construction today.

1.0.2 This bulletin covers the option of using 140 mm framing in external walls, which allows a thicker insulation material to be installed in the walls.

1.0.3 Anyone using the schedule method in Acceptable Solution H1/AS1 to demonstrate compliance with Building Code clause H1 *Energy efficiency* must achieve a construction R-value for external walls of R2.0 in all climate zones (and R2.9 for heated walls).

1.0.4 Calculating the thermal performance of a wall requires consideration of the insulation material installed in the wall and the amount of timber framing. Wall framing reduces thermal performance because heat flows more easily through timber wall framing than it does through insulated cavities. The timber framing is a thermal bridge.

1.0.5 H1/AS1 (in 2.1.4.3 b) states: "For framed walls, the *R-value* shall include the effects of studs, dwangs, top plates and bottom plates, but may exclude the effects of lintels, sills, additional studs that support lintels and sills, and additional studs at corners and junctions". In other words, the current H1/AS1 does not require the full amount of framing/thermal bridging to be considered when determining construction R-value. This exclusion of many parts of the framing is what makes it possible to achieve a nominal construction R-value of R2.0 with 90 mm framing, at least on paper.

1.0.6 Without the exclusion, compliance would be extremely difficult to achieve with 90 mm timber wall framing using typical construction methods in new homes today. For a bevel-back weatherboard wall with 90 mm framing and a typical 35% framing percentage, the construction R-value is R1.7 even when using R2.8 insulation. (The framing percentage shows the area of framing as a percentage of the net wall area – height x length – excluding doors and windows. The research organisation Beacon has found that the average wall framing percentage in a sample (47) of typical new-build houses in Aotearoa New Zealand is 34%.)

1.0.7 The H1/AS1 provision that allows significant parts of the wall framing to be excluded from the calculation for compliance may not be around forever. MBIE has indicated that the exclusion may be addressed in a future update to the H1 Acceptable Solutions and Verification Methods.

1.0.8 MBIE has also indicated that a requirement for walls to provide higher thermal performance is likely to be included in a future Building Code update. The use of 90 x 45 mm timber framing may no longer be possible at that stage using current commonly available insulation materials unless secondary insulation layers are incorporated into the wall.

1.0.9 There are some significant benefits to using 140 x 45 mm timber exterior wall framing that will last for the service life of the house:

- It allows space for insulation with higher R-values, making the house more comfortable and healthy to live in and reducing heating energy costs.
- Slab edge distances may be easier to achieve at bottom plate hold-down fixing locations.
- The framing can overhang the foundation to provide space for insulation around the slab edge.
- It supports greater stud heights and lintel spans.
- Anecdotal evidence suggests that thicker external walls are often perceived by homeowners as providing greater substance or strength or quality and are generally preferred to thinner walls. This affects the perceived desirability, value and saleability of a house.

1.0.10 Specifying 140 mm timber wall framing just in external walls will mean an increase in the total build cost. With good design and construction, this additional upfront cost will be offset during the service life of the house by reduced operating costs for heating/cooling as well as making the home more comfortable and healthy to occupy for that time. It is also cheaper and easier to design and construct walls with higher thermal performance at the original construction stage than it is to achieve this through retrofitting at a later stage.

1.0.11 While the specified 140 mm timber wall framing will typically be radiata pine sawn timber, engineered timber products such as LVL are also readily available in this sizing.

2 IMPROVEMENTS IN THERMAL PERFORMANCE

2.0.1 A deeper wall cavity allows space for higher-performing insulation and makes it easier to comply with (or preferably exceed) the requirements in H1.

2.0.2 Changing to 140 mm exterior wall framing enables a construction R-value of R2.0 or better to be achieved with a wider range of insulation materials.

2.0.3 Increasing the construction R-value in external walls also gives the possibility for trade-offs with insulation in other building elements when using the calculation or modelling methods to demonstrate H1 compliance.

2.0.4 NZS 3604:2011 *Timber-framed buildings* allows external wall framing without dwangs. Ideally, dwangs should not be used unless there is a specific reason for their presence because they increase thermal bridging and reduce the space for insulation. Using less than full-depth dwangs is specifically provided for in NZS 3604:2011. If 45 x 45 mm (minimum) or 70 mm dwangs are used between 140 mm studs, they should be installed flush to either the interior or exterior of the framing as required for fixing interior linings or rigid air barriers or sheet claddings and so on. The use of smaller dwang cross-sections reduces thermal bridging, and thermal insulation can be installed behind them. (Note that some frame and truss manufacturers prefer to use dwangs the same depth as the studs for ease of framing panel manufacture and transport.)

2.0.5 Thermal bridging is a major problem in new house construction. A Beacon research project took measurements from 47 newly constructed houses in Auckland, Hamilton, Wellington and Christchurch and found the average percentage of timber framing compared to wall area was 34% – much higher than generally assumed (BRANZ Report ER53). The percentage of framing found in the walls ranged from 24% to 57%.

2.0.6 Follow-up research (published in BRANZ Report ER64) found that even experienced detailers found it a challenge to get the framing ratio down to 27% on a simple single-storey house design. The research indicates that optimising the percentage of framing in standard 90 mm walls will not lead to a sufficient decrease in percentages of framing (and thermal bridging) to achieve the intention of basic Building Code construction R-value minimums.

2.0.7 The BRANZ *House insulation guide* 6th edition allows quick calculations and comparisons of construction R-value to be made between 90 mm and 140 mm framing.

2.0.8 In some cases, reducing the existing framing by 5% and adding a small amount of extra rigid foam insulation, in conjunction with an external rigid air barrier, may be sufficient to achieve the R2.0 requirement with 90 mm framing. BRANZ *House insulation guide* 6th edition includes rigid air barrier options.

3 OTHER ADVANTAGES OF 140 MM FRAMING

3.0.1 Using 140 mm framing ensures that bottom plate anchor fixings to concrete slabs can be installed achieving greater distances to the edge of the slab. Installing bolts or anchors in a 90 mm bottom plate at slab edges can already be difficult. If the bottom plate width is 90 mm, there is an overhang over the edge of the slab (a minimum 6 mm overhang is regarded as good practice) and some proprietary fixings have minimum edge distance of 50 mm, it can be tricky to locate the fixing with minimal tolerances. Using 140 mm framing removes the difficulty.

3.0.2 The extended overhang provided by a 140 mm bottom plate makes it easier for a designer to specify vertical insulation around the slab edge (Figure 1).

3.0.3 Exterior wall framing of 140 mm gives a notably thicker appearance to the walls, including deeper reveals around windows, and this greater thickness is often perceived by homeowners as an indication of better quality and a stronger building.

3.0.4 Using 140 mm exterior wall framing is a well-proven approach. It is already in common use by a number of architects and designers, and their contractors and subcontractors are happy to continue with this configuration.

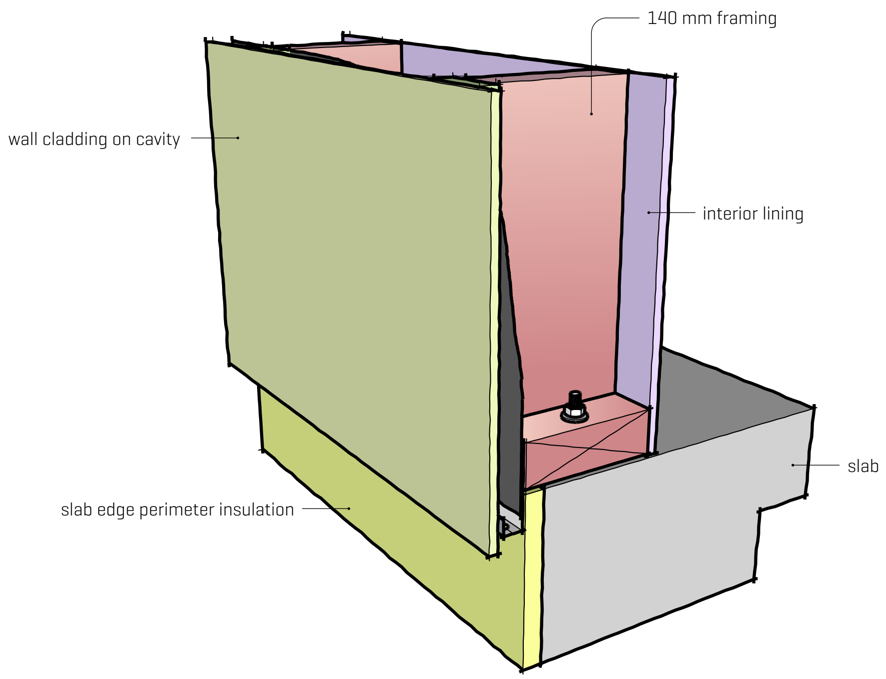

Figure 1. Using 140 mm timber framing reduces the difficulty of fixing bottom plates to the edge of the floor slab and enables a deeper bottom plate overhang to better accommodate vertical slab edge insulation.

4 REQUIREMENTS IN NZS 3604:2011

4.0.1 NZS 3604:2011 is the main standard that sets out the requirements that apply to the timber wall framing in houses.

4.0.2 With 140 mm framing, stud heights can be increased over 90 mm framing at the same centres – see NZS 3604:2011 Table 8.2.

4.0.3 140 mm studs can be installed at wider spaces, helping to reduce thermal bridging and improve thermal performance. Lining and cladding thicknesses need to be considered with wider spacing.

4.0.4 NZS 3604:2011 Table 8.2 covers stud selection for various configurations. Note 2 says: "140 x 45 may be substituted for 90 x 90. 90 x 35 may be substituted for 70 x 45". This means that, where the tables require a 90 x 90 mm stud, it can be substituted with a 140 x 45 mm stud. The reverse is *not* true – where a 140 x 45 mm stud is required in the tables, it ***cannot*** be substituted with a 90 x 90 mm stud. To put it another way, if Table 8.2 requires a given depth of stud, any substitution must be with a greater depth stud.

5 SPECIFYING 140 MM FRAMING VERSUS SECONDARY INSULATION

5.0.1 An alternative or additional approach for enhanced thermal performance of external walls is adding a secondary level of insulation, either external or internal. The BRANZ *House insulation guide* 6th edition includes these options.

5.0.2 One of the most common secondary insulation details for walls is a 45 mm thick interior batten over an air/vapour control layer, creating a secondary cavity that can be insulated (Figure 2). This insulated cavity considerably reduces thermal bridging (in this case, there will only be a complete bridge through both insulated layers where the battens cross the studs), raises the construction R-value and may be used for services such as wiring and plumbing if required. Comparing the construction R-values that can be achieved with this detail with conventional 90 mm timber framing shows that almost a doubling of construction R-values is achievable in some cases.

5.0.3 While a secondary insulation layer gives a significant improvement in thermal performance (especially where the main framing is 140 mm rather than 90 mm), it has two specific drawbacks:

- Its construction requires more labour.
- A plasterboard wall lining can no longer serve as bracing if the cavity is on the inside. The wall therefore needs another form of bracing element such as an element with a seismically rateable rigid air barrier outside the main framing or a seismically rateable rigid air/vapour control layer between the primary and secondary insulation cavities (as appears in Figure 2). Plasterboard bracing can still be used as bracing if the secondary insulation cavity is on the outside of the structural wall framing.

5.0.4 Thermal insulation material must not be installed in the drainage and ventilation cavity behind the exterior wall cladding.

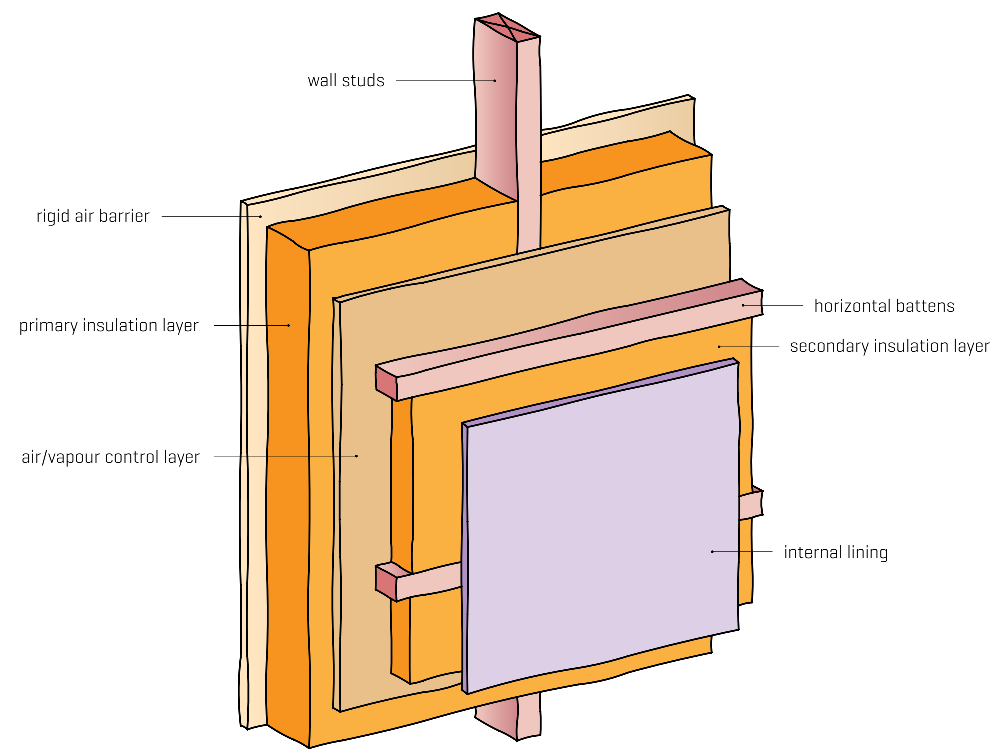

Figure 2. A 45 mm thick interior batten fixed over an air/vapour control layer creates space for a secondary insulated cavity.

6 RESOURCES

BRANZ

BU676 *Complying with H1 – housing, and buildings up to 300 m²*

ER53 *Measuring the extent of thermal bridging in external timber-framed walls in New Zealand*

ER64 *Thermal bridging in external walls: Stage two*

House insulation guide 6th edition

MBIE

Introduction to background reports on H1 Energy Efficiency (Thermal, financial and carbon review of NZBC energy efficiency clause H1/AS1 thermal envelope requirements for residential and small buildings)

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