BRANZ

ISSUE 658 BULLETIN

TIMBER WINDOWS

February 2021

- If correctly installed and maintained, timber windows will still perform satisfactorily after 50 years.
- Timber window installation is outside the scope of Acceptable Solution E2/AS1, so building consent must be applied for as an alternative method.
- This bulletin updates and replaces Bulletin 481 of the same name.

1 INTRODUCTION

1.0.1 Windows in early New Zealand houses were single-glazed frames made from native softwood and hardwood timbers such as rimu, mataī, tōtara and kauri. In the 1970s, aluminium windows became popular due to their lower cost (aluminium windows are approximately one-half to one-third of the cost of timber windows) and perceived low maintenance. Today, aluminium windows have the lion's share of the window market. It is estimated that only around 3–4% of window joinery work deals with timber windows, and of this percentage, approximately one-third is the manufacture of new timber joinery, generally to match existing windows for additions and renovations.

1.0.2 Most work involving timber windows is in retrofitting insulating glass units (IGUs or double glazing) into single-glazed timber sashes. One joiner estimates that this makes up approximately 80% of their work. The remaining 20% of their work typically involves refurbishing or replacing windows.

1.0.3 Although seldom installed in new building work, timber windows have many advantages including that timber:

- is durable
- is sustainable and renewable
- has a low carbon footprint
- has excellent thermal performance
- has aesthetic appeal
- has profiles that can easily be modified
- allows refurbished and replacement windows to blend seamlessly with existing.

1.0.4 There has been little change in the manufacture of timber windows in New Zealand in many years, and if correctly installed and maintained, and with regular maintenance, timber windows can still perform satisfactorily after 100 years in moderate environments.

1.0.5 This bulletin updates and replaces Bulletin 481 of the same name.

2 TIMBER WINDOW DESIGN

2.0.1 Windows are classified according to their method of opening. Classifications include:

- casement or side hung
- awning
- fanlight (or toplight)
- double hung (vertical sliding)
- horizontal sliding
- bifolding
- louvre
- fixed sash
- tilt and turn – a European window system not yet widely used in New Zealand, this offers two opening options: side hinged and inward opening or tilted from the bottom with the top of the window angled into the room to provide a small opening for ventilation while maintaining security
- tilt and slide – also a European system not commonly used here, this is typically used with doors and has a sliding sash that can be tilted for ventilation, which is particularly beneficial for small spaces when in tilt position as additional windows are not required.

2.0.2 Windows can generally be associated with particular housing styles and provide an indication of the age of a house.

2.0.3 The different parts of a window are shown in Figure 1.

2.0.4 Traditionally, timber windows have been single glazed, but New Zealand Building Code clause H1 *Energy efficiency* generally expects that windows in new construction incorporate IGUs. The types of glass and design criteria for single glazing and IGUs are described in:

- NZS 4223.1:2008 Code *of practice for glazing in buildings – Glass selection and glazing*
- NZS 4223.2:2016 *Glazing in buildings – Part 2: Insulating glass units*
- NZS 4223.3:2016 *Glazing in buildings – Part 3: Human impact safety requirements*.

3 TIMBER TYPES AND TREATMENT

3.0.1 NZS 3602:2003 *Timber and wood-based products for use in building* specifies timber species, treatments, grades and moisture content for timber-based building components. The timbers specified for use for external joinery including frames, sills and sashes are:

- radiata pine
- redwood
- western red cedar
- cypress species (including macrocarpa, Mexican cypress and Lawsons cypress).

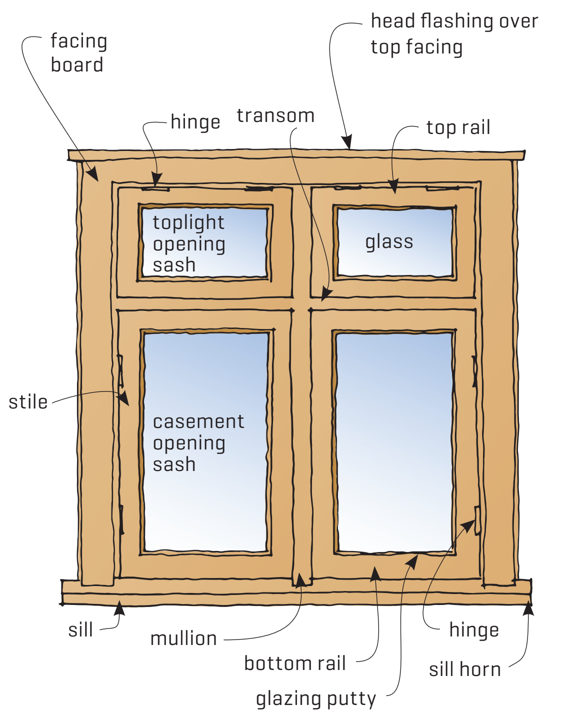

Figure 1. Parts of a window.

3.0.2 In New Zealand, western red cedar is the most commonly used timber for sashes for new windows. It is stable, durable, has a natural resistance to decay, is lightweight with a good strength-to-weight ratio and is easy to work with. Western red cedar sashes are typically combined with H3.2 treated radiata pine frames.

3.0.3 A wide range of other timbers can be used. The principal criteria are that the timber should be dimensionally stable and have a straight grain. Other timbers that may also be used for windows include (but are not limited to) Alaskan yellow cedar, jarrah, pine, rimu, kauri and rosawa.

3.0.4 Building Code clause B2 *Durability* requires that windows have a durability of not less than 15 years. It cites NZS 3602:2003 and NZS 3640:2003 *Chemical preservation of round and sawn timber*, which require that radiata pine for exterior joinery is treated to hazard class H3.1 and is expected to be painted. However, joinery manufacturers generally recommend that radiata pine for use as exterior joinery and facing boards is treated to H3.2.

4 TIMBER WINDOW PERFORMANCE

4.1 THERMAL PERFORMANCE

4.1.1 Timber is a poor conductor of heat due to its cellular structure, which traps air and acts as a natural insulator.

4.1.2 The thermal performance of a material is measured as the resistance to the flow of heat through the material or R-value. It has units of R = m²°C/W. A high R-value indicates a high resistance to heat flow and good thermal performance. Table 1 compares the R-values of window frame and glass combinations with different frame materials. It shows that timber typically performs better than both aluminium and thermally broken aluminium.

4.2 LIFE CYCLE ASSESSMENT AND EMBODIED ENERGY OF TIMBER

4.2.1 Life cycle assessment (LCA) is a method of measuring the environmental impact of a building material throughout its life. Part of this includes assessing the global warming potential (or carbon footprint) as a result of the release of greenhouse gases from the material.

4.2.2 Embodied energy describes the energy required to produce and deliver a building material to a building site. As energy consumption produces CO_2, embodied energy is considered an indicator of the overall environmental impact of the building material.

4.2.3 Embodied energy differs from carbon footprint by considering only the front-end aspect of the impact of the material – it does not include the operational impact or disposal of the material.

4.2.4 Some building materials such as cement and aluminium require large energy inputs during manufacture. In comparison, timber requires no purchased energy input during growth and relatively little during harvest and manufacture. In addition, while trees are growing, they store atmospheric carbon, which remains sequestered or locked in the timber for the service life of the timber and is only released back into the atmosphere when the timber decays or is burned.

5 TIMBER WINDOW CONSTRUCTION

5.0.1 Timber window frames and sashes are still made in the same way as they always have been, which means that they are easy to repair, replace and match with new joinery.

5.0.2 Sash joints are typically mortise and tenon joints (Figure 2). This joint consists of a tenon or tongue cut into a rail and fitted into a square or rectangular slot or mortise cut into the stile that matches the size and shape of the tenon. Once fitted, the joint is glued and stapled to create a strong and stable joint.

5.0.3 The window frame is typically assembled using plain housed joints. The sill extends beyond the jambs so the cladding, facing boards and scribers can be shaped and fitted around the sill.

5.0.4 Moisture-cure polyurethane wood glues are often used for timber window frame joints. These glues foam slightly during curing, which facilitates the adhesive being driven into the wood fibres and improves the adhesion of the timber. Polyurethane wood glues also have good water, heat and chemical resistance but retain flexibility even after they have cured.

Table 1. Comparison of window frame and glass combinations R-values.

Window frame material	Single glazing	IGU with 4 mm glass and 8 mm air space	IGU with 4 mm glass and 12 mm air space	IGU with 4 mm glass, 12 mm air space and low-E pane	IGU with 4 mm glass, 12 mm air space, low-E pane and argon gas fill
Timber	R0.19	R0.34	R0.36	R0.47	R0.51
uPVC	R0.19	R0.34	R0.36	R0.47	R0.51
Fibreglass	R0.19	R0.34	R0.36	R0.47	R0.51
Thermally broken aluminium	R0.17	R0.30	R0.31	R0.39	R0.41
Aluminium	R0.15	R0.25	R0.26	R0.31	R0.32

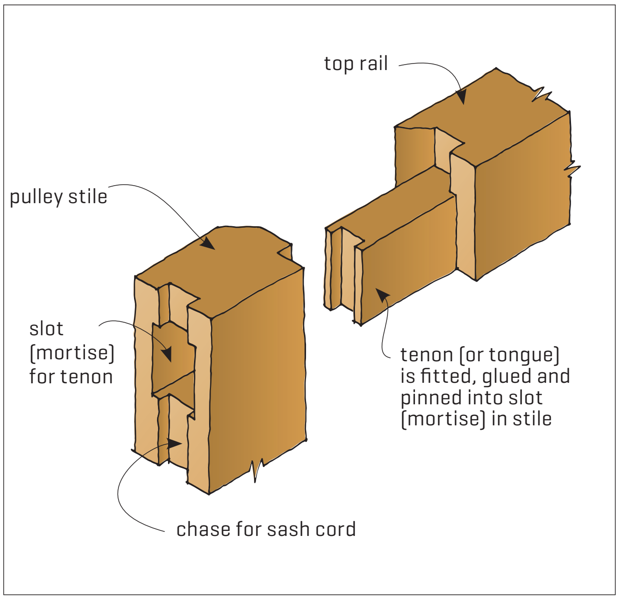

Figure 2. Mortise and tenon joint.

6 TIMBER WINDOW INSTALLATION – BUILDING CODE COMPLIANCE

6.0.1 Window installation generally must comply with the requirements of Building Code clause E2 *External moisture*. Acceptable Solution E2/AS1 provides a means of compliance for installing aluminium windows into different types of external wall cladding, but it does not include timber window installation. As it is outside the scope of E2/AS1, building consent for timber window installation must be applied for as an alternative method, which requires demonstrating to the consenting authority that the installation will meet the performance requirements of clause E2. (Once accepted, it becomes an Alternative Solution.)

6.0.2 Demonstrating compliance may be achieved by:

- making a comparison with an Acceptable Solution
- testing or comparing using a Verification Method (E2/VM1 and E2/VM2 currently include window junctions)
- making a comparison with other relevant documentation
- making a comparison with in-service history of similar windows – as timber windows have been used with weatherboard, masonry veneer and stucco claddings for many years, documentation providing evidence of the in-service history of similar timber windows with one of the traditional claddings is likely to be a valid option to support the use of the proposed system
- making a comparison with a previously accepted Alternative Solution
- obtaining expert opinion.

6.0.3 As with window installation, the window itself must also show compliance with the Building Code. The main means of demonstrating compliance is to have the joinery tested in accordance with NZS 4211:2008 *Specification for performance of windows*, which is cited by E2/AS1. This standard defines the weathertightness requirements for external windows and doors not requiring specific design and provides the basis for testing weathertightness performance requirements for air leakage and wind zone rating. Some joinery manufacturers have worked together to have specific timber joinery profiles tested to NZS 4211:2008. Joinery that has met the testing requirements has an identification tag, typically installed on the frame in the rebate of a window sash, that includes a unique identification number, references the standard and describes the relevant wind zone and air leakage ratings. NZS 4211:2008-compliant timber joinery product and installation details can be downloaded from https://jmfnz.co.nz/installation-preparation-information/

7 TIMBER WINDOW INSTALLATION – ALTERNATIVE SOLUTION

7.0.1 The first step is to undertake a risk assessment of each façade of the building envelope using the risk matrix from E2/AS1 and, based on the risk score and the selected cladding, determine whether the cladding may be direct-fixed or should be fixed over a cavity.

7.0.2 The process to demonstrate timber window installation compliance with clause E2 can be based on the E2/AS1 aluminium window installation details. This includes:

- wall underlay installation into the frame opening
- window head details
- installation of an air seal
- the requirement for a sill tray flashing.

7.1 PREPARATION OF THE FRAME OPENING

7.1.1 Cut the flexible wall underlay at 45° into each corner of a window opening, then fold and secure into the frame opening. Where rigid wall underlay is required, this must be overlaid by a flexible wall underlay.

7.1.2 Install flexible flashing tape over the wall underlay:

- at the top corners to extend at least 100 mm along the window head and at least 100 mm down the jamb
- across the full opening width of the sill and turned up 100 mm at both jambs
- carried 50 mm down the external face of the opening at both the top and bottom of the opening (Figure 3).

7.1.3 Where the sill sits fully on the sill trimmer, fix a sill packer cut to suit the slope of the timber sill to the sill trimmer before the wall underlay and flexible flashing tape are dressed into the opening.

7.1.4 Alternatively, fit a flashing support packer over the flexible flashing tape dressed over the sill trimmer (Figure 4).

7.1.5 Fix cavity battens over the flexible wall underlay if the cladding is to be fixed over a cavity.

7.2 SILL TRAY FLASHING

7.2.1 For direct-fixed cladding, install a sill tray flashing:

- for the full width of the opening between the trimming studs
- with a 20 mm upstand along the back edge of the tray and 20 mm upturns at each end
- that slopes to the exterior

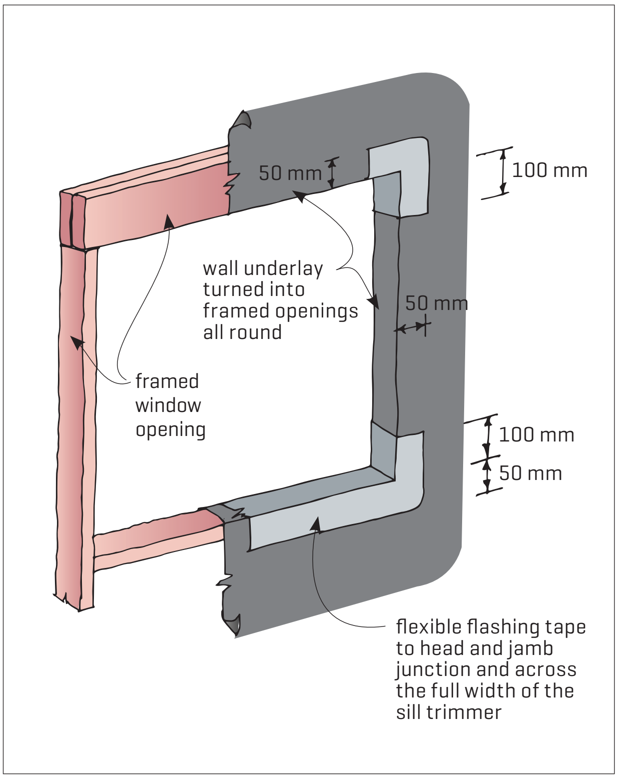

Figure 3. Window penetration preparation.

- that overflashes the lower cladding by a minimum of 35 mm and has a drip edge at its bottom edge.

7.2.2 For cavity construction, under E2/AS1, a sill tray flashing is not required for aluminium window installation. However, BRANZ recommends that a sill tray flashing as for direct-fixed cladding is also installed in timber windows with cavity construction.

7.3 WINDOW HEAD FLASHINGS

7.3.1 The window head may be finished with either a head facing board or a head cap (Figure 5).

7.3.2 Where a head facing board is to be installed, the head flashing should have:

- a minimum 15° slope carried down and folded tightly over the head facing board
- a 10 mm minimum downturn with a kick-out
- a 50 mm minimum upstand with a 35 mm minimum overlap of the cladding (in extra high wind zones, the upstand should be a minimum of 75 mm with 60 mm minimum overlap of the cladding, and the upstand should have a hook or hem)
- an additional layer of wall underlay or flexible flashing tape lapped over the flashing upstand
- a 5 mm anti-capillary gap between cladding and flashing.

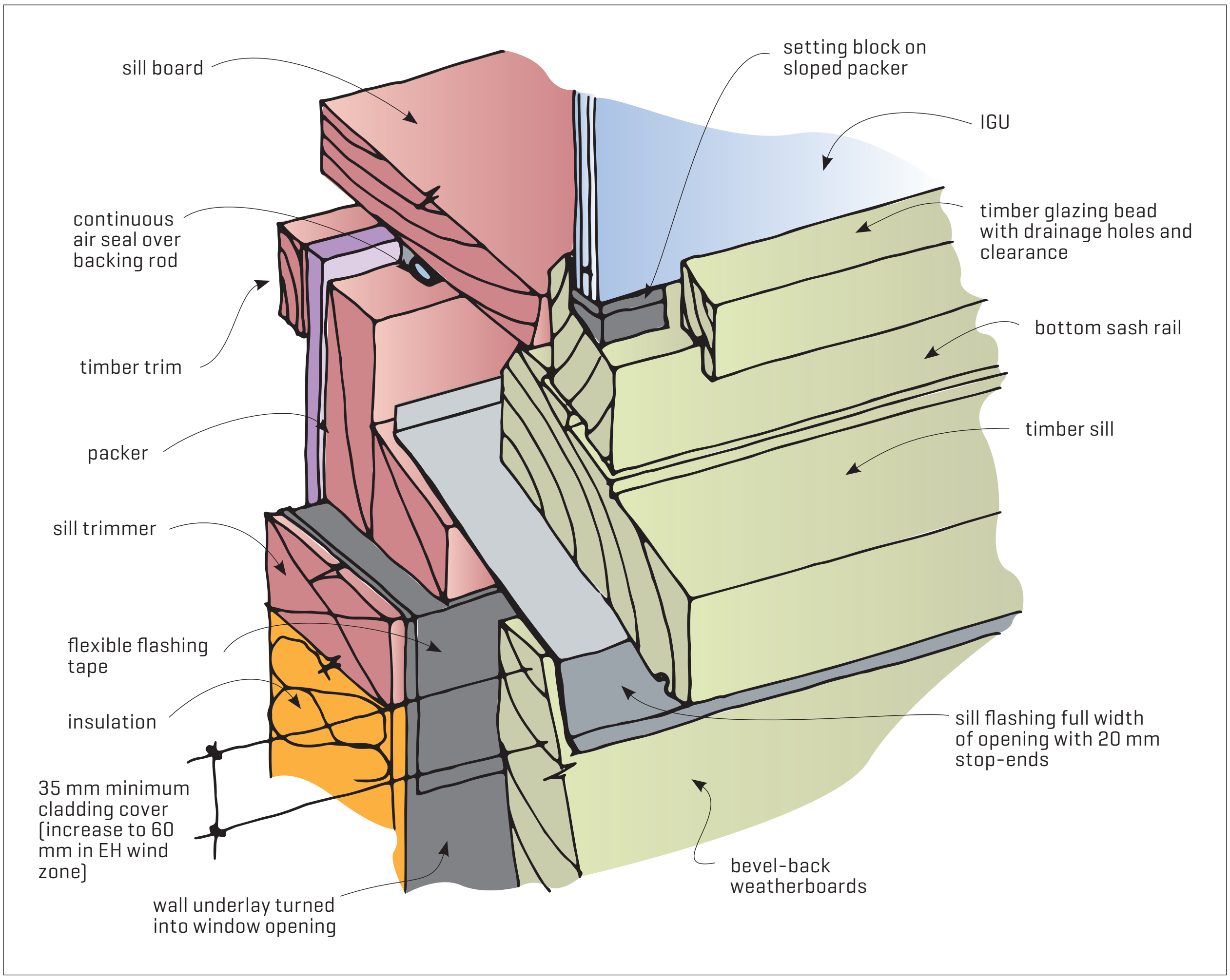

Figure 4. Timber window sill detail – direct-fixed cladding.

7.3.3 For direct-fixed construction, each end of the window head flashing should have a 50 mm long strip of sealant applied between the underside of the cladding and the head flashing.

7.3.4 For cavity construction, each end of the window head flashing should have a 10 mm stop-end that terminates at the inside face of the cladding and does not pass through the cladding.

7.3.5 A timber head cap as per the profile in NZS 3610:1979 *Specification for profiles of mouldings and joinery* may be installed instead of a head facing board in higher weathertightness risk situations. The timber head cap should extend at least 20 mm beyond the outer edge of the jamb facings, have a minimum 15° slope to shed water and have a drip edge at the bottom. The flashing should be fixed over the head cap with a 10 mm minimum downturn and a kick-out.

7.4 AIR SEAL

7.4.1 Install a continuous air seal consisting of expanding foam sealant over a backing rod around the framed opening and the window reveal. The seal, along with the interior lining, creates an air barrier preventing air leakage, which may also drive water leakage, into the building interior.

7.4.2 As of November 2020, an addition to the E2/VM1 test was being developed by BRANZ to cater for the installation of windows into different domestic-oriented construction systems. This test method should add more robustness to the existing tests within E2/VM1 and E2/VM2 for window installation weathertightness.

8 GLAZING INSTALLATION

8.0.1 Glazing in timber windows is housed in primed rebates cut into the sash and fixed and sealed using putty or glazing sealant with timber beading around the glass edges. Putties and glazing sealants must be flexible and allow the glass to move.

8.0.2 Setting blocks support the dead weight of the glass in the rebates and also keep the bottom edge of the glass above the bottom of the rebate. The supporting surface of setting blocks must be level so they should be set on packers or be shaped to match the slope of the rebate. NZS 4223.1:2008 provides general guidelines for their location, which must provide an equally distributed support. Other requirements include that they must be:

- at quarter points but not less than 30 mm from corners
- at least the width of the thickness of the glass being supported

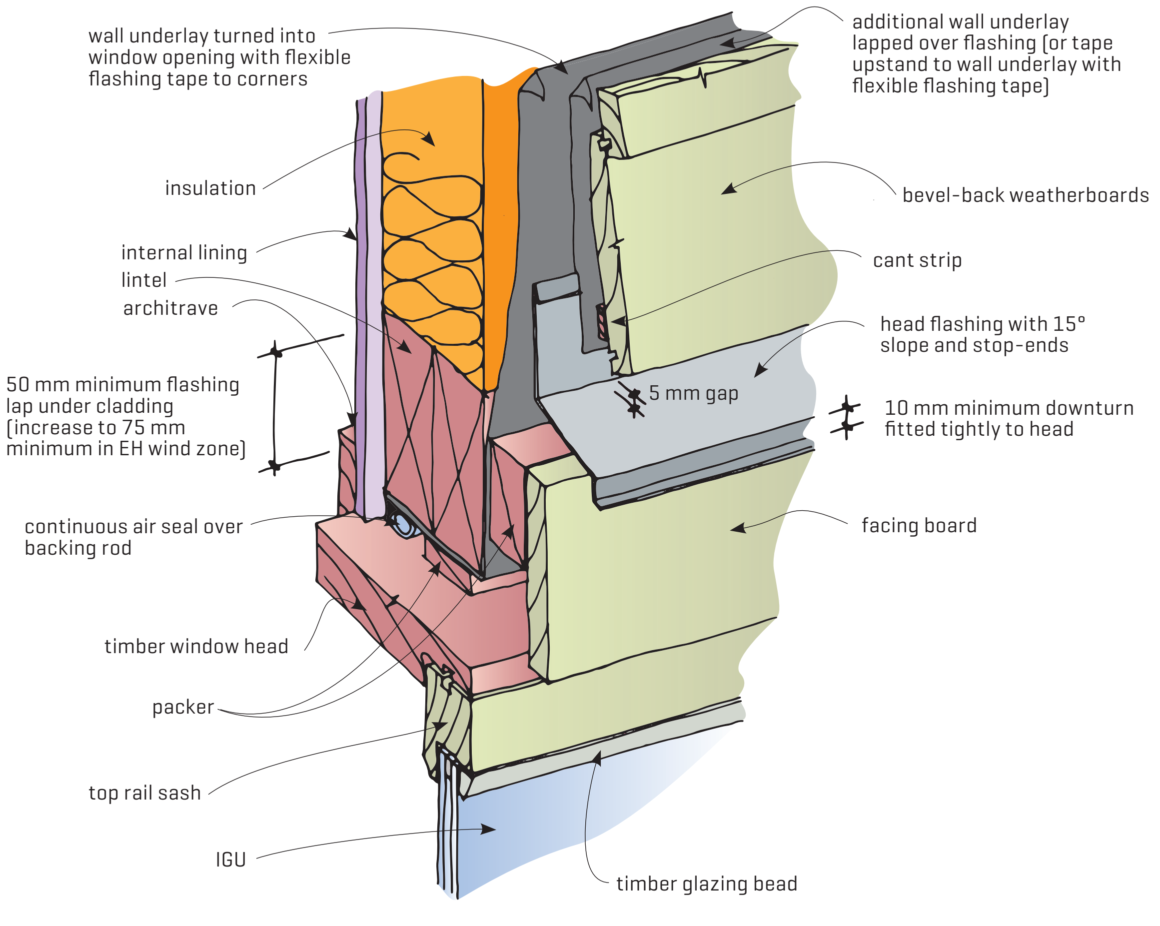

Figure 5. Timber window head detail with head cap – direct-fixed cladding.

- 6 mm minimum thick for drained glazing systems
- at least 25 mm long for each square metre of glass
- compatible with the glazing material they support.

8.0.3 Putties are typically used for single glazing. Putty both fixes the pane in position and provides a seal against water ingress.

8.0.4 IGUs are typically fixed into the sash using timber beading with either butyl glazing tape or silicone sealant to provide the seal against water ingress.

8.1 LINSEED OIL-BASED PUTTY

8.1.1 Linseed oil-based putty has traditionally been used for single glazing timber windows. The rebate must first be painted with an oil-based primer. Once dry, a bed of putty is pressed into the rebate and the glass forced into the putty. It is held in place with tacks or glazing points and sealed with putty around the external edges of the face of the glass. The putty must be painted over and the paint should extend approximately 2 mm over the glass to provide the primary seal against water ingress.

8.1.2 Linseed oil-based putty skins over in 24–48 hours but it cannot be painted until it has hardened. This can take 2 weeks or longer depending on air temperature. The delay in painting over putty means linseed oil-based putty is now less often used.

8.1.3 Linseed oil-based putty must not be used with laminated glass, coated solar-control glass or IGUs as linseed oil can react with the plastic layer in laminated glass, the coatings on solar control glass and the sealant in IGUs.

8.2 SYNTHETIC FAST-DRYING PUTTIES

8.2.1 Synthetic fast-drying putties are acrylic formulas that are used in a similar way to linseed oil-based putties but they skin over and harden quickly and are therefore able to be painted after 24 hours. They are used in conjunction with a compatible bedding compound that is applied to the inside face of the rebate. The glass is placed over the bedding compound in the rebate and held in position with glazing points, and the synthetic putty is applied to the external edges of the face of the glass.

8.2.2 Synthetic putties should only be used with laminated or treated glass in accordance with manufacturers' instructions, and they should not be used with IGUs.

8.3 BUTYL GLAZING TAPES

8.3.1 Butyl glazing tapes are elastomeric compounds that are extruded into strips for use as a weather seal. They have excellent durability and adhesion and are available in a range of lengths and thicknesses. Butyl glazing tapes are suitable for use in timber glazing where a watertight (but drainable) cavity is required, such as with IGUs.

8.4 SILICONE SEALANTS

8.4.1 Silicone sealants are silyl-modified polymers (SMPs). They are high-performance, flexible, fast-curing sealants that can be painted as soon as a skin has formed. Silicone sealants keep their elasticity and stability in both high and low temperatures and are resistant to chemicals, moisture and weathering.

8.4.2 Before applying any glazing sealant, the surfaces should be sound, clean, dry and free from grease, dirt and other loose material. It is recommended that a primer is used with all glazing sealants. Ensure that the primer is dry before applying the sealant.

8.5 TIMBER GLAZING BEADS

8.5.1 IGUs consist of glass panes separated by spacers with a sealant applied to the perimeter edge of the unit to protect it from moisture ingress or internal gas loss. Some IGU perimeter sealants are incompatible with glazing sealants and none can tolerate prolonged wetting, so IGUs are generally installed using timber glazing beads and drained rebates.

8.5.2 Timber used for the glazing beads is generally western red cedar. Beads are fixed to the edge of the sash using stainless steel brads or pins.

8.5.3 Drainage can be provided by:
- cutting a minimum 15° slope to the bottom rebate of the timber sash
- installing minimum 6 mm thick setting blocks either shaped or located on packers to keep the bottom edge of the IGU above the bottom of the rebate
- a minimum of three 6 mm diameter holes (minimum) or 5 mm wide slots (minimum) is recommended through the timber beads to allow water that enters the rebate to drain out.

8.5.4 Timber glazing beads are recommended for use with large panes of glass and with laminated, tinted and coated glass. They must also be primed on inside faces prior to installation. Mitred cuts at corners must also be primed.

9 RETROFITTING IGUs

9.0.1 Retrofitting single-glazed timber sashes with IGUs can significantly improve the thermal performance of the window. IGUs can be retrofitted into almost any type of timber window as long as the sash profile has sufficient depth and strength to hold the IGU (Figure 7).

9.0.2 A building consent is not required for retrofitting IGUs into existing window sashes, but all building work must comply with the Building Code.

9.0.3 Hardware such as hinges and stays often need to be replaced to be able to cope with the additional weight of the IGU. Double-hung windows must have heavier weights installed to counteract the weight of the IGU.

9.0.4 A procedure to retrofit an IGU into an existing timber sash is as follows:

- Remove the window sash from the frame and take out the existing single glass pane(s).
- Rout out the glazing rebate to fit the thickness of the IGU. Cut the bottom rebate to create a 15° slope towards the exterior face of the sash to provide drainage. Most sashes have a bevel or ovolo profile on the interior face. In order to ensure the internal profile is not altered, the routing procedure should leave at least 1–2 mm depth of the bevel or ovolo profile.
- Apply a silicone sealant or butyl glazing tape to the face of the rebate.
- Place silicone setting blocks as required in the bottom rebate. The setting blocks must have a level top surface to support the glass.
- Set the IGU into the rebate on the setting blocks.
- Apply additional glazing tape around the exterior face of the glass.
- Fix timber beads around the IGU to hold the glass in position. The bottom rail bead has a deeper profile than the stile and top rail beads, typically with an overhanging 'tongue' that sits at least 5 mm proud of the sash to provide a drainage gap. Holes that may be concealed in the bead provide drainage so that any water that enters between the glass and the bead can drain out.
- Fix stile and top rail beads over the glass. Offset the beads from the face of the sash by 1–2 mm to conceal any irregularities in the sash.

9.0.5 A range of proprietary systems for retrofitting IGUs into existing sashes are also available.

9.0.6 Leadlight windows can be encased between two panes of clear glass to improve the thermal performance of and provide protection to the leadlight. The level of thermal performance is limited as the air gap created is small and the lead jointers are generally close to or touching the glass. Once a leadlight pane has been encased in glass, it can be reinstalled into the existing sash rebate following the same procedure as installing an IGU.

10 FINISHES FOR TIMBER WINDOWS

10.0.1 For effective protection against UV and weathering, the exterior faces of timber windows should be painted. Internal faces may be painted, polyurethaned or stained.

10.1 PAINTING

10.1.1 Western red cedar has a high resin content, which gives the timber good durability but the resin may bleed through the primer. To prevent bleeding, this timber must either be painted with an oil-modified alkyd primer or with one of the waterborne primers that have been developed to nullify bleeding.

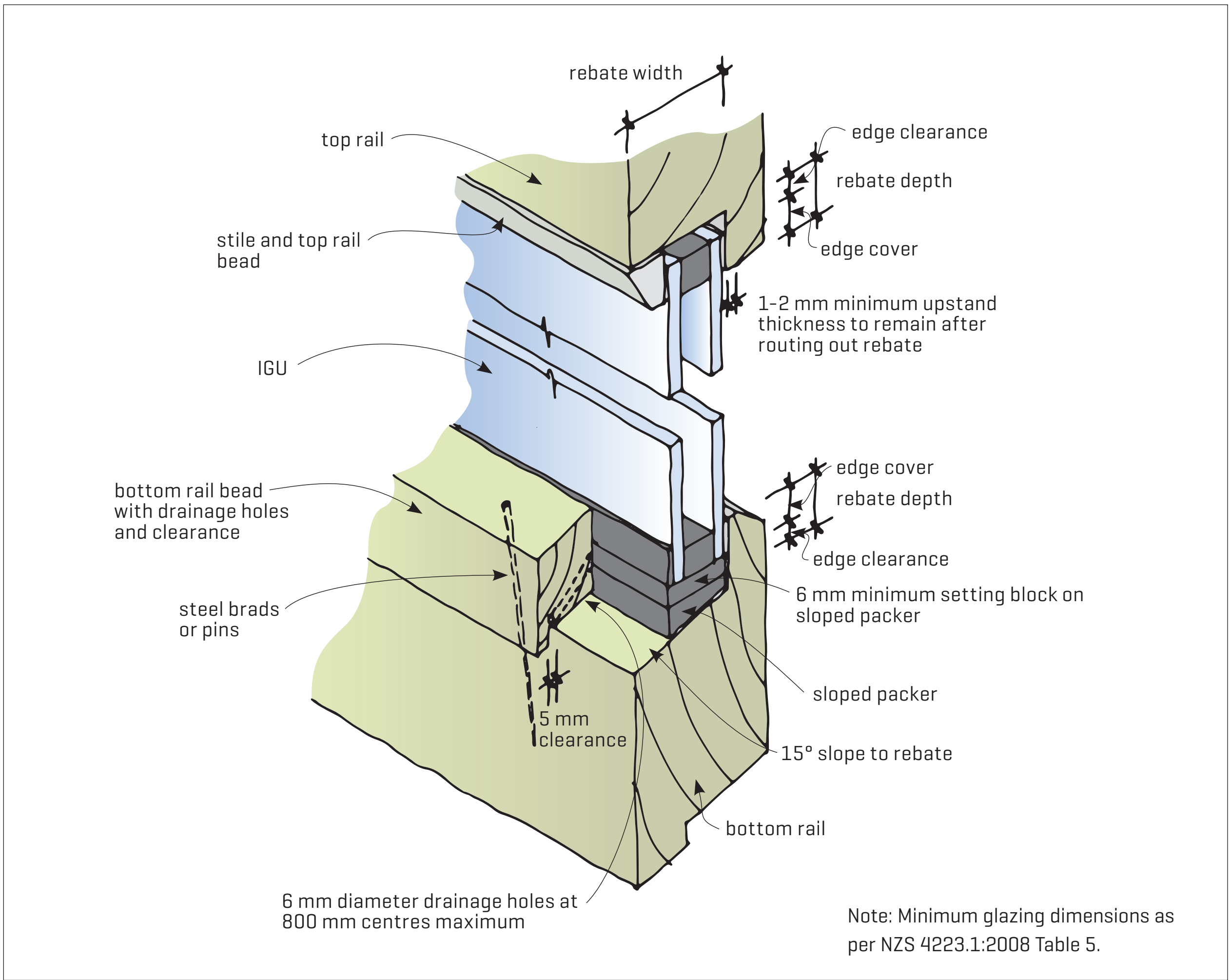

Figure 7. Retrofitting an IGU into a single-glazed sash.

10.1.2 Traditionally, full-gloss solventborne enamel paint was used to paint window frames and sashes and may still be used. However, the development of modern paints with lower environmental impact and improved resistance to UV and ease of application means waterborne enamels are now preferred.

10.1.3 The timber should have a minimum of two top coats of paint, but three top coats is recommended.

10.1.4 The top, bottom and inside edges of the window sash should be painted to ensure a good moisture seal and help reduce swelling of the timber.

10.1.5 Windows that have been puttied with a linseed oil-based putty should not be painted until the putty is firm to touch – typically at least 14 days. A synthetic fast-drying putty may be painted after 24 hours.

11 MAINTENANCE AND REPAIRS

11.0.1 Lack of maintenance and water leakage are the main causes of rotting of window frames and sashes. Typical causes of water ingress include:

- inadequate flashings
- deterioration of the paint, putty or sealant
- no capillary gaps
- poorly fitting opening sashes
- bowed or twisted sashes.

11.0.2 Checking timber windows should be carried out at least annually, in particular inspecting the condition of the:

- timber frames and beading
- paint finish
- putty
- hardware.

12 MORE INFORMATION

NEW ZEALAND BUILDING CODE CLAUSES

Clause B2 *Durability*

Clause E2 *External moisture*

NEW ZEALAND STANDARDS

NZS 3602:2003 *Timber and wood-based products for use in building*

NZS 3610:1979 *Specification for profiles of mouldings and joinery*

NZS 3619:1979 *Specification for timber windows*

NZS 3640:2003 *Chemical preservation of round and sawn timber*

NZS 4211:2008 *Specification for performance of windows*

NZS 4223.1:2008 *Code of practice for glazing in buildings – Glass selection and glazing*

NZS 4223.2:2016 *Glazing in buildings – Part 2: Insulating glass units*

NZS 4223.3:2016 *Glazing in buildings – Part 3: Human impact safety requirements.*

BRANZ PUBLICATIONS

BRANZ Bulletin 659 *Upgrading the thermal performance of timber windows*

BRANZ Good Repair Guide *Timber windows*

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ISSN 1178-4725 (Print) 2537-7310 (Online)