BRANZ

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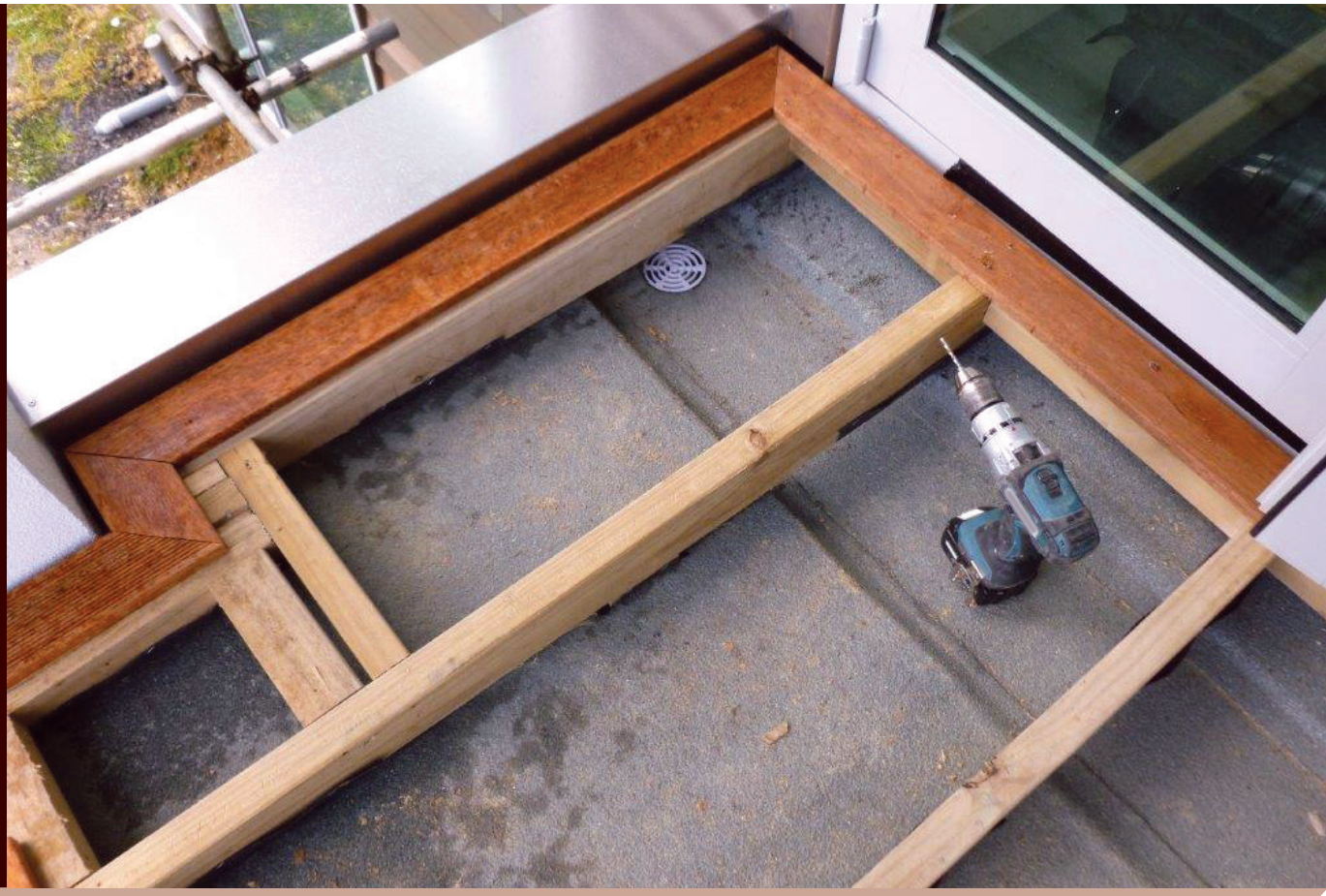

WATERPROOF DECKS

April 2015

Constructing waterproof decks as external living areas over habitable spaces is common in timber-framed residential buildings.

Such decks have had a less-than-satisfactory history of performance as a result of poor detailing and construction.

This bulletin discusses the requirements of E2/AS1, alternative options, and design and construction risks. It updates and replaces Bulletin 472 of the same name.

1.0 INTRODUCTION

1.0.1 A waterproof deck is essentially a low-slope roof that is designed to accommodate loads from foot traffic when used as an outdoor living space. Typically, they are constructed with timber framing, a plywood substrate and waterproof membrane and could be over a habitable living space.

1.0.2 As they form part of the weathertight envelope for a building, they must meet the performance requirements of the New Zealand Building Code (NZBC) clause E2 *External moisture*.

1.0.3 This bulletin discusses the design and construction issues that are critical to achieve reliable performance for timber-framed waterproof decks. It covers the requirements of E2/AS1, alternative options to E2/AS1 and the risks associated with the design and construction of waterproof decks. It replaces and updates Bulletin 472 of the same name.

2.0 COMMON PROBLEMS WITH WATERPROOF DECKS

2.0.1 Historical weathertightness failure statistics have highlighted deck failures resulting from:
- leaks at balcony wall junctions with adjacent walls
- insufficient or reverse fall to the deck surface and surface ponding
- relying on a textured finish without flashings to waterproof the tops of enclosing balcony walls
- flat tops to solid balcony walls
- finishing the top of balcony walls with the wall cladding
- insufficient membrane upturn
- undersized or insufficient outlets
- no or undersized overflow provision
- unsuitable membrane (for example, the membrane cannot tolerate regular foot traffic)
- incorrect substrate joint or change in plane treatment for the selected membrane, which could overstress the membrane causing failure along the lines of the joints/junction
- poorly installed external membrane corners.

2.0.2 Other reported problems, not necessarily related to weathertightness, have included:
- incorrect framing spans and/or centres for the loads or substrate thickness, which causes undue deflection in the deck
- plywood substrate too thin
- overloading by occupants.

2.0.3 Unprotected waterproof deck membranes can also be damaged by:
- puncturing by sharp objects or point loads such as heels or outdoor furniture
- fixings working out of the substrate
- solvents accidentally spilled on the surface
- hot items spilt from barbecues.

2.0.4 A waterproof deck is one feature that specifically increases the weathertightness risk score when using the risk matrix in E2/AS1 to assess each face of a building.

3.0 NZBC REQUIREMENTS

3.1 E2/AS1 EXTERNAL MOISTURE

3.1.1 Waterproof decks designed to E2/AS1 require:
- a substrate of H3 CCA-treated, CD structural grade plywood at least 17 mm thick
- 150 mm minimum membrane upstands (above the finished deck level) around the perimeter of the deck
- a 35 mm minimum clearance (to the deck surface) at the bottom of the cladding
- a minimum threshold at doors of 100 mm – where provision for level access is to be provided, a removable raised walk-on surface shall be provided
- a 40 m^2 maximum area
- a 1.5° (1:40) minimum fall or slope
- butyl or EPDM membranes only
- no changes in surface level except into gutters
- no integrated roof gardens
- no downpipes discharging onto the deck
- internal gutters with a minimum fall of 1:100 and a minimum cross-sectional area of 4000 mm^2 – no cross joints are permitted within the gutter
- removal of water from the deck area (note that E1/AS1 may require larger outlets) by:
  - 75 mm minimum diameter in-roof outlets, or
  - scupper outlets into a rainwater head with a 300 mm minimum width, or
  - through parapet or balcony walls using a scupper outlet at least 200 mm wide by 75 mm high
- for enclosed decks with internal water outlets, at least two outlets and overflows, each able to cope with the maximum calculated water run-off – if the second outlet is an overflow, the size must be 1.5 times the calculated downpipe area
- a complete system of membrane, adhesive, primer and seam tape.

3.1.2 While the waterproof membrane material selection is limited under E2/AS1, the detailing requirements of the Acceptable Solution may be applied to the design of any waterproof deck.

3.1.3 The application of directly applied wearing or decorative surfaces is not covered in E2/AS1. Protective measures for waterproof membranes under E2/AS1 are limited to removable:
- concrete pavers or other panels on proprietary support pedestals (Figure 1)
- timber slats or plywood panels on timber packers (Figure 2).

3.1.4 Protective measures outside the scope of E2/AS1 may include directly bonded paving or tiles.

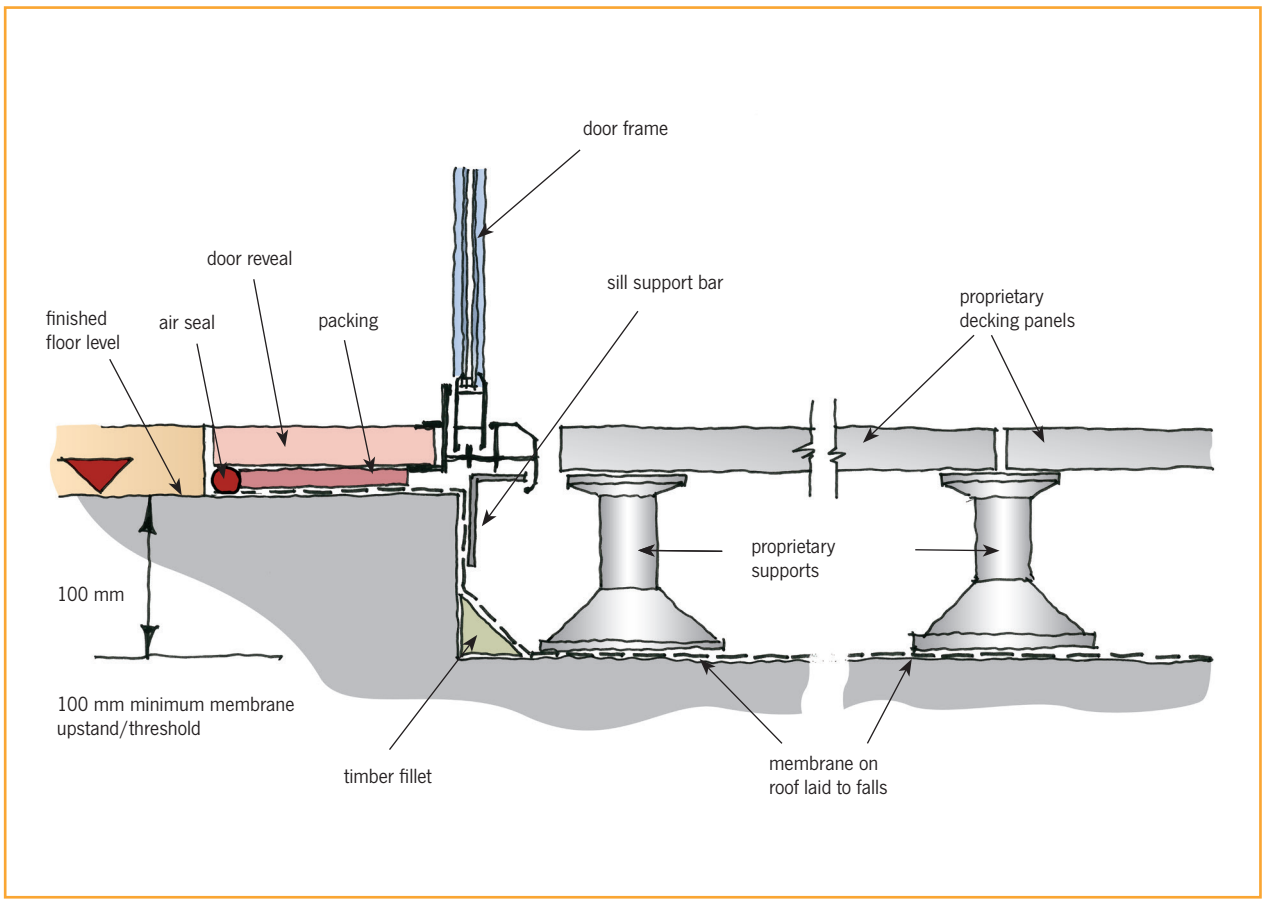

Figure 1. Level threshold with proprietary raised surface.

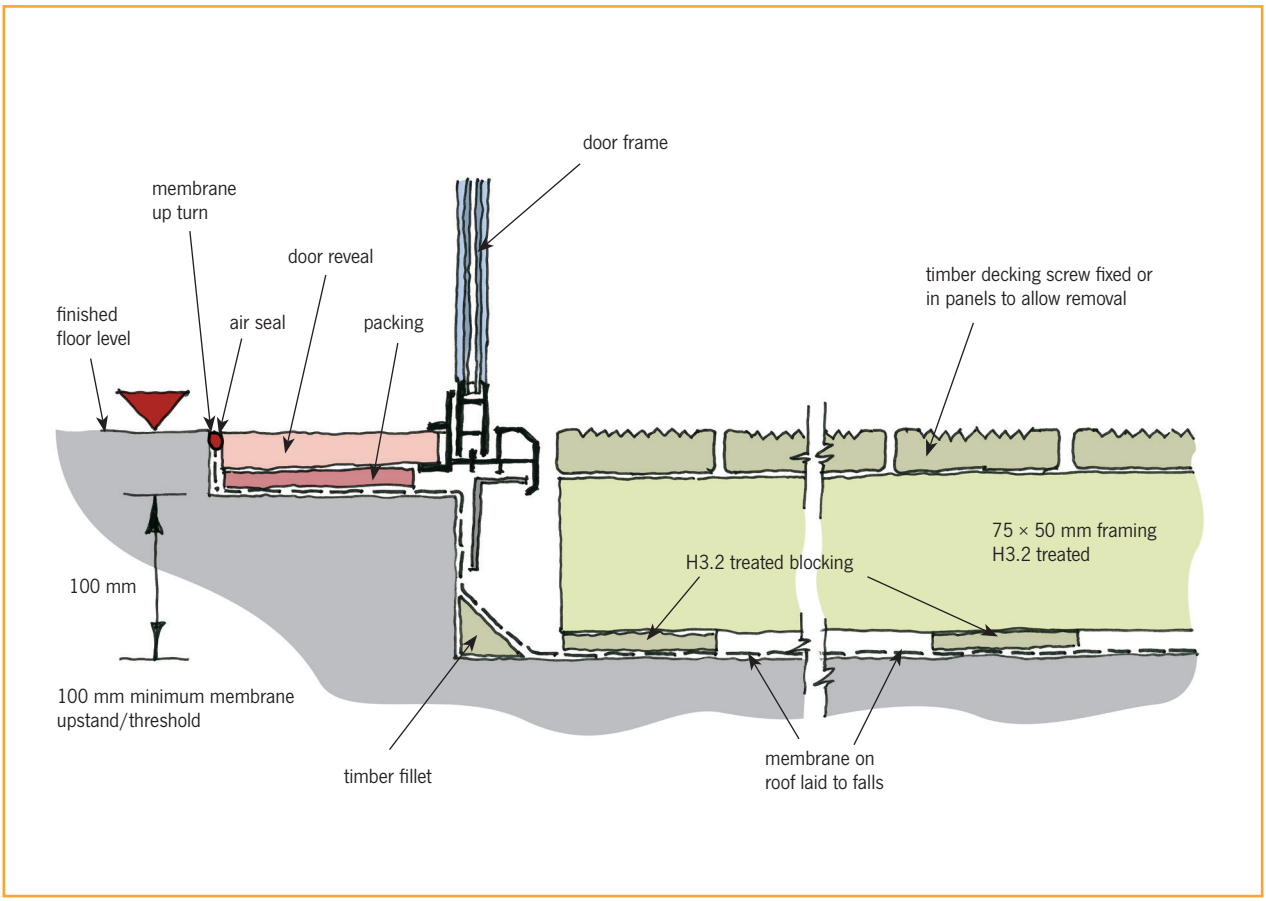

Figure 2. Level threshold with timber-slatted surface.

3.2 B1/AS1 STRUCTURE

3.2.1 NZS 3603:1993 *Timber structures standard* and NZS 3604:2011 *Timber-framed buildings* require trafficable/accessible decks to be designed for 2 kPa live loading.

3.2.2 Deflections of the substrate will be reduced by decreasing joist spacing or span (BRANZ recommends by 20%) or using thicker plywood.

3.3 B2/AS1 DURABILITY

3.3.1 B2/AS1 requires a minimum durability of 15 years with normal maintenance for the waterproof deck membrane and the life of the building but not less than 50 years for the framing and plywood substrate. Framing that is fully enclosed is required to have a treatment of H1.2.

3.4 D1/AS1 ACCESS ROUTES

3.4.1 Waterproof deck surfaces that provide access to a building (main entry point from the street) must have a slip resistance coefficient of not less than 0.4 when wet (D1/AS1).

3.4.2 Decks not forming part of an access route have no statutory slip resistance requirement. However, selecting a surface that provides slip resistance is considered good design to provide safer conditions for users.

4.0 DECKS OUTSIDE THE SCOPE OF E2/AS1

4.0.1 Alternative methods are all those construction methods, details or materials not covered by an Acceptable Solution. Once an alternative method is accepted and consented by a building consent authority (BCA) as being Code compliant, it becomes an Alternative Solution.

4.0.2 Deck designs that must be submitted for consent as an alternative method to show compliance with NZBC clause E2 are those where:

- membranes other than butyl or EPDM are specified (for example, evidence of sufficient durability will need to be provided)
- tiles or other surfacing is adhered to the waterproof membrane
- gutter and downpipe outlets do not achieve the minimum dimensions called for in E2/AS1
- handrails or barriers are top-fixed
- water from adjacent roofs discharge onto the deck
- the deck is outside the parameters given in section 3.1 – for example, a concrete substrate or a deck larger than 40 m^2.

4.0.3 Designers of alternative methods for decks outside the scope of E2/AS1 must provide sufficient evidence to a BCA to demonstrate that their proposed solution meets the performance requirements of the NZBC. Examples are:

- verified evidence of membrane durability
- product-specific installation details
- the provision of access to the membrane for inspection and maintenance.

4.0.4 A typical compliance path for a waterproof deck may use comparison with the details in E2/AS1 plus, for the waterproof membrane, a successful history of use, durability opinion or product appraisal or CodeMark certification.

5.0 DESIGN CONSIDERATIONS

5.1 DECK DESIGN AND LAYOUT

5.1.1 Key aspects of waterproof deck design:

- Integrate the deck framing with the remainder of the structure and the support requirements for the plywood substrate.
- Integrate sufficient falls into the deck design/layout to provide sufficient drainage over the life of the deck. Achieving the 1.5° minimum fall is difficult and can be negated if a deck deflects – to ensure long-term drainage is provided, increase the fall to 3° (the increased slope can be masked by the removable walk-on surface installed at floor level). Note that some BCAs are requesting a greater deck slope than that in E2/AS1.
- The design of the enclosure to the deck – decks may be enclosed by full-height walls or low (not less than 1 m high) solid, open or partially open barrier walls.
- The shape of the deck – for example, decks that wrap around a building corner or are larger than 40 m^2 may require movement control joints in the substrate and membrane.
- Incorporate the location of outlets and overflows into the design – providing at least two outlets and corresponding overflow for a fully enclosed deck is considered good practice.
- Avoid disposing of water from a roof above onto the deck.
- Where subject to snow loads, allow for a build-up of snow, and detail outlets to prevent blocking.
- Lay out the deck membrane to minimise membrane sheet joints.

5.2 DECK-TO-WALL CLADDING JUNCTIONS

5.2.1 For designs following E2/AS1, waterproof membranes that abut the wall or solid balustrade cladding must:

- turn up 150 mm (above the deck surface) behind the wall cladding at perimeter walls
- at doorways, return under the door sill
- be lapped under cladding, typically by 115 mm
- have a clearance of at least 35 mm between the deck surface and the cladding
- have triangular fillets (20 x 20 mm finished) (Figure 3) at the deck-to-wall junction and other changes of direction – these help reduce membrane stress at the junction
- provide a threshold height of not less than 100 mm.

5.2.2 Some membranes not covered by E2/AS1 can have a pencil cove at deck upstand transitions.

5.3 HANDRAILS

5.3.1 Handrails should be fixed to the vertical faces of solid balustrades (Figure 4). Penetrations through

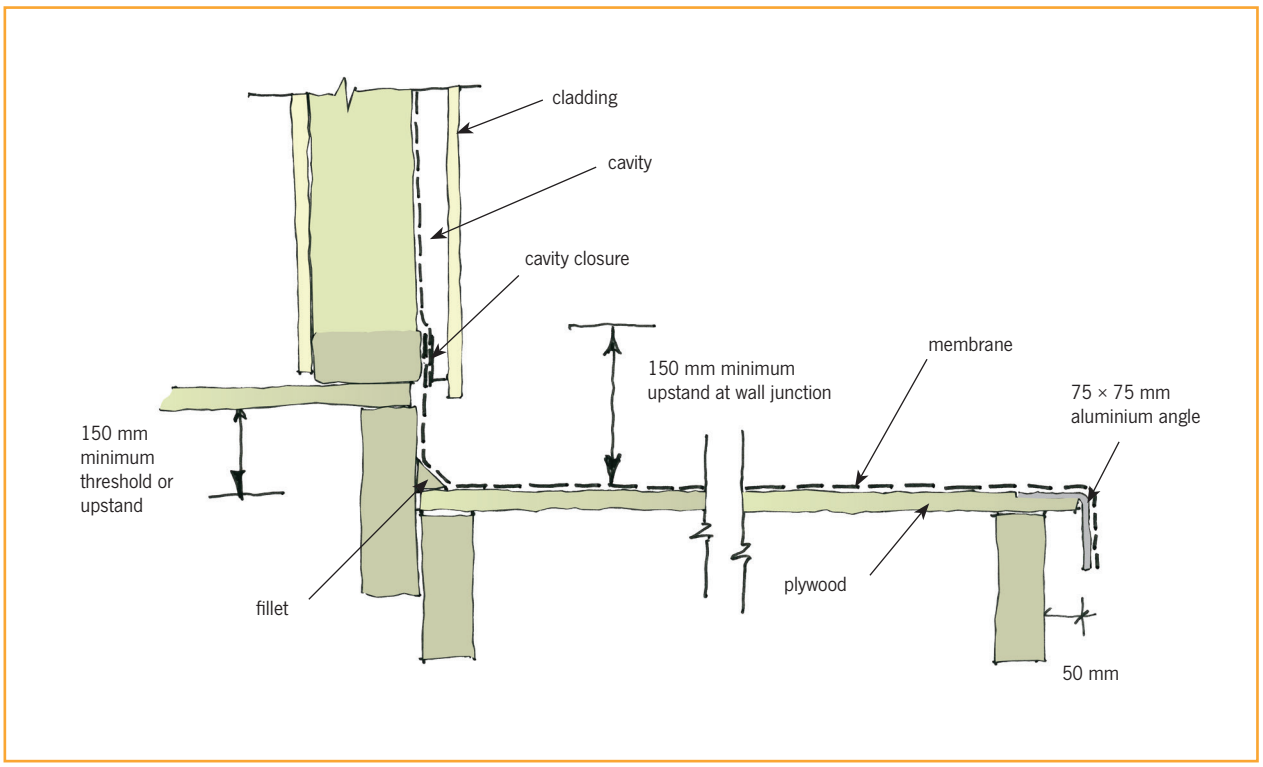

Figure 3. Deck-to-wall cladding junction. Corner fillets and chamfers reduce risk of wrinkles at changes of direction.

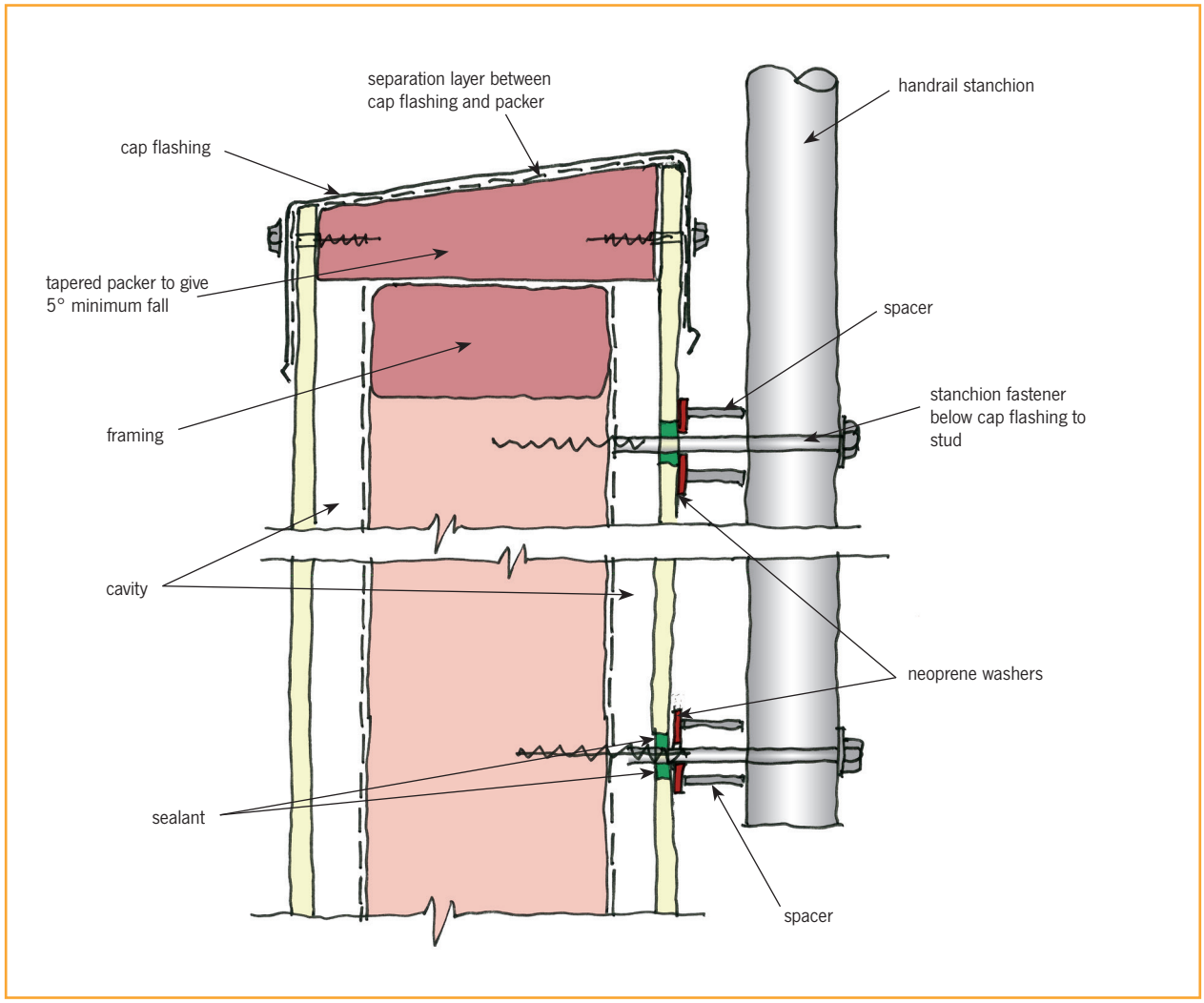

Figure 4. Attachment of stanchion for handrail to enclosed balustrade.

the surface of the membrane or through the top of a solid framed balustrade wall are not recommended because of the increased risk of water penetration.

5.4 OPEN BALUSTRADES

5.4.1 Open balustrades, or partial barriers allowing drainage to an external gutter, can avoid the risks associated with blocked outlets and overflows where a deck is fully enclosed by solid walls. Avoid installing fixings for open balustrades through the horizontal deck membrane. Open barriers allow the barrier to be spaced off the adjacent wall cladding and avoid a high-risk junction.

5.5 SOLID BARRIER WALLS

5.5.1 Solid barrier walls are those that fully enclose the deck area with a framed and clad wall at least 1 m high. For designs to E2/AS1, barrier wall claddings are required to be installed over a drained and vented cavity and not be in plane of exterior walls – that is, not be a continuation of an exterior wall.

5.5.2 The solid balustrade wall junction with adjacent walls (Figure 5) must:
- incorporate a saddle flashing
- provide for the cavity to drain safely at deck level
- be fitted with sloping cap flashings or be underflashed as detailed in E2/AS1 for EIFS and texture-coated fibre-cement claddings
- have a minimum cross-fall for cap flashings of 5° or 10° when textured and underflashed.

5.6 MEMBRANE SELECTION

5.6.1 Waterproof membranes suitable for walk-on decks are limited by E2/AS1 to an EPDM or butyl rubber of 1.5 mm minimum thickness. Other options, which must be submitted for consent as an alternative method, include:
- PVC, modified PVC, TPO and KEE membranes
- waterborne liquid-applied acrylic membrane systems
- waterborne liquid-applied polyurethane membrane systems
- torch-on modified bitumen with a protective/wear system
- acrylic modified cementitious coatings with a protective/wear surface.

5.6.2 Sheet membrane joints are a potential failure point so should be kept to a minimum. Jointing options include:
- site-adhered laps (E2/AS1 requires seam tape to adhere joints where the slope is less than 5° and for EPDM membranes)
- heat welding (PVC, TPO, KEE)
- torched seams/joints.

5.6.3 Applied surface finishes (such as ceramic tiles) may increase the service life of flexible waterproof membranes by protecting them from UV radiation and physical damage, but they prevent monitoring of the ongoing condition of the waterproof membrane. However, these are outside the scope of E2/AS1.

5.7 ACCESSORIES

5.7.1 Consideration should be given to using:
- proprietary through-wall scupper outlets – forming the membrane into a through-wall scupper outlet is difficult, and using a preformed sleeve reduces the risk of water entry
- proprietary within-gutter or deck area sumps at drainage points
- dome-type covers for internal outlets to reduce the risk of blockage (except where this could constitute a trip hazard)
- a roof outlet that incorporates a flange to finish the membrane over and a screw-fixed grate to clamp the membrane in place.

6.0 DECK CONSTRUCTION

6.0.1 Treatment of timber framing for decks and balustrades is covered in Table 1A of B2/AS1, which modifies Table 10 of NZS 3602:2003 *Timber and wood-based products for use in building* and specifies H1.2 as the minimum treatment level for enclosed decks and solid balustrade framing.

6.0.2 Falls to the deck surface must be incorporated into the framing set-out.

6.0.3 Substrates for waterproof deck membranes can be:
- plywood (E2/AS1)
- compressed sheet fibre-cement
- concrete.

6.0.4 Under E2/AS1, plywood substrates for waterproof decks must:
- be a minimum of 17 mm thick CD structural grade
- have a maximum span of 400 mm
- be laid with face grain at right angles to the joists
- be H3 treated (NZS 3602:2003) – H3 LOSP-treated plywood is not permitted for use with most membrane systems currently available because the solvent used in the treatment may affect the performance of the adhesive and/or membrane
- have a maximum moisture content at the time of membrane application of 20% (16–18% is better) – the 20% maximum moisture content also applies to timber framing
- have sheet edges fully supported
- have sheets installed in a staggered joint pattern
- be fixed with stainless countersunk head screws – refer to the membrane supplier's installation instructions on finishing screw fixing points, as some require the fixing to be flushed off with a filling compound or sealant
- have sheets installed with a 3 mm edge gap – membranes outside the scope of E2/AS1 may have different sheet edge jointing requirements (for example, substrate joints in butyl, EPDM and some liquid-applied systems are covered with 25 mm minimum width polyethylene tape, while substrate joints under PVC and some liquid-applied membranes may be flush stopped)
- have 5 mm chamfers to all external edges.

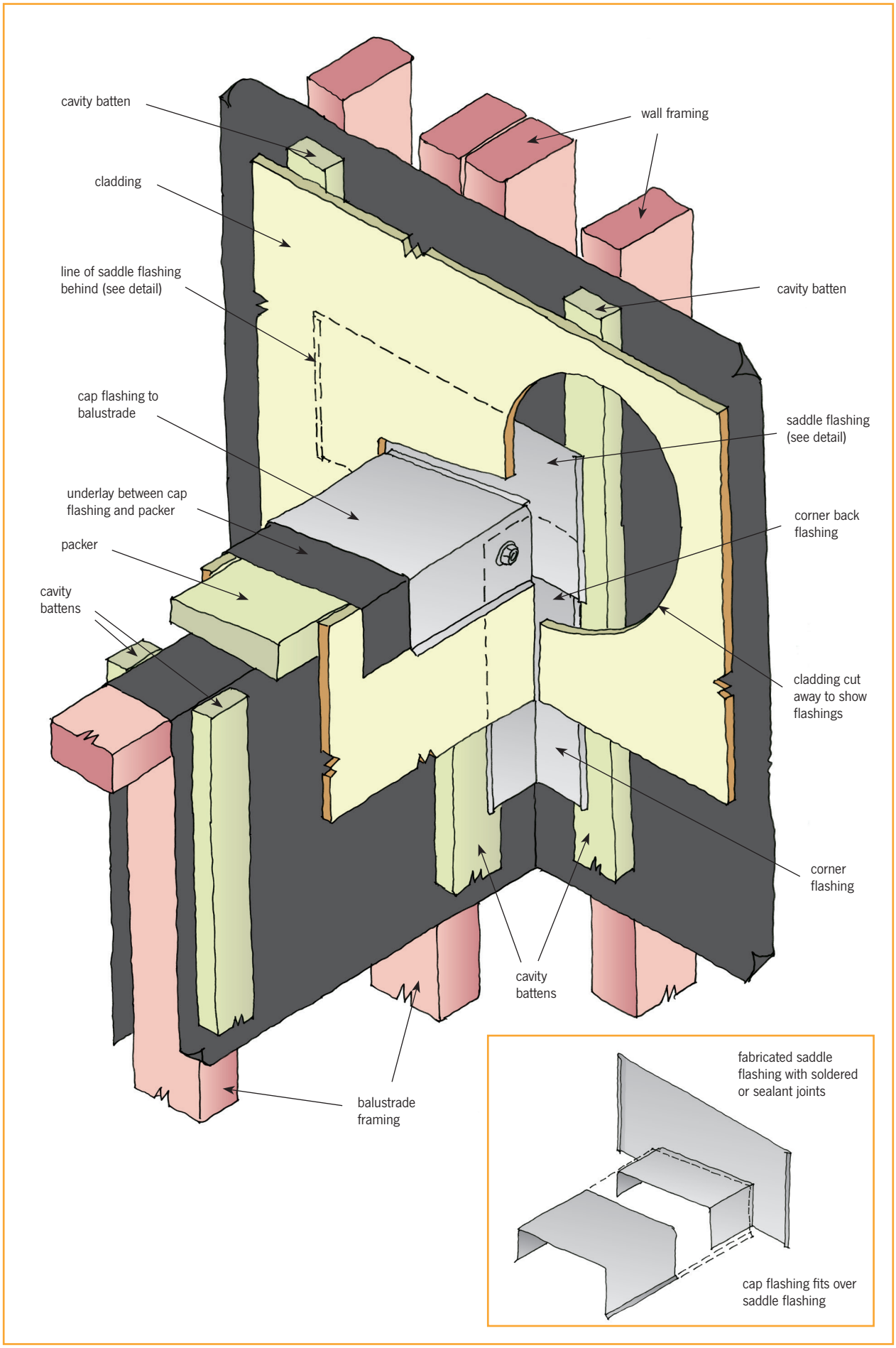

Figure 5. Enclosed balustrade to cladding junction.

6.0.5 Other requirements may include:
- sanding off any unevenness or lipping between plywood sheets at joints
- rebating the plywood for the membrane joints
- allowing a perimeter expansion gap between the plywood and adjacent wall framing of 5 mm
- laying membrane as soon as practicable after plywood installation to prevent wetting.

6.0.6 Substrate requirements for materials other than plywood are covered in BRANZ Good Practice Guide *Membrane Roofing*.

6.0.7 After plywood substrate installation, protect the surface from wetting until the membrane system can be installed. Allow concrete substrates to cure and dry. It is recommended that the surface is protected from wetting in the week before membrane application.

7.0 MEMBRANE INSTALLATION

7.0.1 Each membrane manufacturer has specific details and installation requirements for their product, which must be followed for their warranties to be validated.

7.0.2 All waterproof membrane systems require installation to be carried out by accredited applicators.

7.0.3 Before laying the waterproof membrane, check that:
- all plywood and fibre-cement substrate sheet edges are supported and fully fastened
- screws are countersunk
- sheet joints are correctly prepared for the specified membrane
- edges are prepared as detailed, particularly when discharging to a gutter
- angle fillets (Figure 3) are installed when required by the membrane supplier
- substrates are dry
- surfaces are clean
- the substrate is primed/sealed as required.

7.0.4 When installing membranes, ensure:
- the temperature of the surface is within the manufacturer's specified range at time of laying (generally controlled by adhesive used)
- air temperature and weather conditions are suitable.

7.0.5 For sheet membranes, ensure:
- material is unrolled and allowed to relax to remove curvature induced by being tightly rolled before laying (achieved by being laid flat at recommended laying temperature)
- the correct adhesive/primer is used with sheet materials
- underflashings to external membrane corners are installed before the sheet laying starts
- sheet materials are progressively applied to the adhesive/primer to avoid creating air pockets – for torch-on membranes, they are rolled out and heated to adhere them to the substrate
- substrate is prepared for the sheet jointing – for example, joints in PVC membrane are formed in small routed rebates in the substrate
- where adhesive is used, it is the type specified by the membrane supplier
- protective surface finish is applied as required – see 5.6.3.

7.0.6 For liquid-applied membranes:
- for two-component systems, follow mixing instructions precisely
- mix thoroughly
- apply within the recommended open time
- when reinforcing is used, coat the surface and lay the reinforcing into the wet membrane and let it cure before applying a second coat to fully encapsulate the reinforcing
- ensure the correct dry film thickness is achieved
- apply the required number of coats within the recommended time limits
- ensure that any reinforcing is fully encapsulated within the membrane
- allow to cure
- apply a protective surface finish to cementitious membranes.

7.0.7 Additional installation requirements for the membranes listed in section 5.6 are outlined in BRANZ Good Practice Guide *Membrane Roofing*.

7.0.8 After installation, provide temporary protection for waterproof membranes to protect them from damage by other trades. Ensure temporary loads, such as scaffolding supports, have plywood pads under the supports and are distributed to prevent excessive local deflections and point loads.

8.0 MAINTENANCE

8.0.1 Because a waterproof membrane is often a single layer with no second line of defence against water entry, it requires yearly inspection for damage. Damage that occurs should be repaired immediately to limit consequential damage.

8.0.2 Where water entry is suspected or has occurred as a result of membrane damage or poor deck detailing, the deck structure should be inspected by a member of the New Zealand Institute of Building Surveyors to determine the extent of the damage and advise on the repair options.

8.0.3 Where removable walk-on surfaces are used, care is needed to ensure that the contact area does not have sharp edges or fasteners that could damage the waterproof membrane.

8.0.4 Liquid-applied membranes will need to be regularly recoated in accordance with the manufacturer's recommendations to ensure their ongoing performance – typically every 7–10 years.

9.0 FURTHER READING AND STANDARDS

Ministry of Business, Innovation and Employment (MBIE), Building and Housing
Acceptable Solution B1/AS1 to clause B1 *Structure*
Acceptable Solution B2/AS1 to clause B2 *Durability*
Acceptable Solution D1/AS1 to clause D1 *Access routes*
Acceptable Solution E2/AS1 to clause E2 *External moisture*

Standards New Zealand
NZS 3601:1973 *Metric dimensions for timber*
NZS 3602:2003 *Timber and wood-based products for use in building*
NZS 3603:1993 *Timber structures standard*
NZS 3604:2011 *Timber-framed buildings*

AS/NZS 2269 *Plywood – Structural*

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Good Practice Guide *Membrane Roofing*

Membrane Group New Zealand Inc.
Code of Practice for Torch-on Membrane Systems for Roofs and Decks

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