Buildi Housi
Te Tari Kaupapa Whare

BRANZ

Weathertightness:

Guide to Remediation Design

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CONTENTS

1 INTRODUCTION

1.1 Purpose and limitations

The goal of weathertightness remediation is a cost-effective solution that remedies the situation, reduces future risk and restores the confidence of the building owner. The purpose of this guide is to provide some basic information to assist building designers undertaking design of weathertightness remediation solutions.

The guide covers high-level processes for designing weathertightness remediation from a building perspective. It focuses largely on the aspects that are particular to weathertightness remediation rather than the usual design process.

The particular circumstances of each remediation need to be considered when designing repair work, and this guide does not replace the need for professional advice from appropriate knowledgeable consultants. The guide includes a number of concept diagrams to stimulate thinking about design solutions to overcome design faults and to reduce risk, but the actual circumstances and specific design of a remediation must be considered on a case-by-case basis. Following this guide does not relieve the designer from the obligation to consider what is required in the particular circumstances and will not, by itself, ensure compliance with the Building Act 2004 and the New Zealand Building Code. Other legal requirements, such as resource consent matters, are not considered in this guide.

Remediating leaky buildings is a complex task that requires expert input from building surveyors, designers, engineers, remediation specialists and builders. The history of litigation around leaky buildings also means that it is important that the designer, as well as the owner, seeks legal advice where necessary.

Each of these parties must have the necessary education, expertise, experience and, where necessary, additional specialist training and mentoring. This guide is not a substitute for this.

The guide is a joint Department of Building and Housing/BRANZ initiative and incorporates contributions from experts within the building industry.

The use of this guide does not relieve the users of the guide (including designers and owners) of their responsibility to comply with the Building Act 2004, the New Zealand Building Code, the Resource Management Act 1991 and local planning schemes, any professional or other legal obligations and anything else relevant to the particular circumstances of the particular remediation.

1.2 Scope of the guide

The guide is primarily written to cover buildings:

- within the scope of NZS 3604 *Timber framed buildings*
- typically built within the period 1993–2004 that have timber framing with either reduced treatment levels or no treatment and therefore are more susceptible to timber decay if the building leaks
- typically built with direct-fixed monolithic cladding.

However, the processes outlined in this guide will be applicable for most buildings requiring weathertightness remediation.

1.3 Audience

This guide is aimed primarily at architects and designers but may also be of use for Building Consent Authorities and owners.

1.4 Reference documents

A number of other publications may be of use in the design process for remediation of a leaky home. The companion documents to this guide (available from **www.dbh.govt.nz**) include:

- *External moisture – a guide to using the risk matrix*
- *External moisture – an introduction to weathertightness design principles*
- New Zealand Building Code Acceptable Solutions E2/AS1[1] and B2/AS1
- *Weathertightness: Guide to the diagnosis of leaky buildings*.

1.5 Leaky home context

The guide acknowledges that there may be claims, litigation or similar matters taking place while remediation is being carried out. However, this guide is not intended as advice on claims or liability, and any person with concerns or questions about a claim should seek their own independent legal advice.

It is acknowledged that potential and actual claims impact on the remediation process in a number of ways and can affect the relationship between the parties involved and the extent or nature of remediation work undertaken. For that reason, this guide highlights some areas where a claim may impact on the remediation process. However, such comments are intended as guidance only and do not replace professional advice.

1 The Acceptable Solution E2/AS1 represents current practice in building to achieve Building Code clause E2 *External moisture*. E2/AS1 provides details and information about how buildings can be built to achieve weathertightness.

2 AT THE START

2.1 Understanding the owner's situation

At the beginning of any discussion on remediating a leaky home, it is essential to develop an understanding of the owner's situation.

Owners may be under stress and concerned they may own a leaky building. Some may be involved in or planning a claims process through the courts or the Weathertight Homes Resolution Service (WHRS) in an attempt to recover funds from those involved in the original building process.

At the start of the process, it is important that the designer obtains a good understanding of the owner's expectations and limitations. Questions to be asked include:

- Has the owner initiated or are they intending to pursue any claims?
- What do they want to achieve through remediation – Code compliance or more?
- What features of the building can they afford to upgrade?

If the owner indicates that they are pursing a claim, it is the owner's responsibility to seek any necessary advice about how the claim might affect the remediation.

2.2 The role of the designer

A designer may be commissioned directly by an owner or by other parties involved in remediating leaky buildings such as a builder or a remediation specialist (for example, a member of the New Zealand Institute of Building Surveyors who has completed additional training).

A designer needs to understand their role in the project and their relationship to the other parties before undertaking the design.

They must have the requisite skills and experience or access to an experienced advisor to undertake the design work that their role requires.

A designer taking the lead in the project and doing all detailing and site supervision will need greater skills and experience than a designer contracted to a remediation specialist who is vetting details and providing advice, design co-ordination and site supervision.

It is important that designers understand and manage their responsibilities and potential liability when involved in remediation design.

2.3 Contractual relationships

There is likely to be a number of parties involved in remediating a leaky building, and as a result, the contractual relationships can be complex. Legal advice should be sought in respect of all contracts. The designer may contract directly with the owner or may be contracted by a remediation specialist. The agreement between the parties in each situation should be tailored to the particular circumstances (based on legal advice) and recorded in a written contract so that each party understands their rights and obligations.

The designer may also be a party to the contract with the builder or may be responsible for the supervision of the works carried out under the contract between the builder and the owner. Therefore, it is important that the designer seeks legal advice on the effect of the arrangements with the builder.

In some places, this guide refers to matters that might be included in the designer's contract. These recommendations do not replace the need for legal advice.

2.4 Design commissioning

Weathertightness remediation has many uncertainties that can affect the final scope and cost of the work. Building assessments are carried out before cladding is removed, so the full extent of the damage, particularly to untreated framing, will not be discovered until this occurs.

As knowledge of the underlying construction increases and damage is exposed, the level of uncertainty reduces. The potential for costs to increase once the full extent of the damage is known means that it is advisable for designers to include a provisional sum for these unknown factors and an overall contingency allowance in their contract with the owner.

Remediation projects may involve complex technical issues and may go beyond moisture-damaged building elements, for example, structural, fire or insulation issues. Due to the extent of unknown factors that may arise during the process, it is advisable for designers to consider how increases to the works required and the associated costs will be dealt with when entering into a contract with the owner.

2.5 Documentation and record-keeping

Documentation and record-keeping during the project is essential. Although it may not be intended at the outset, records may take on particular importance where the owner pursues a claim for compensation.

A typical project file would include:

- the diagnostic report including recommendations
- estimates of the costs of the remediation work
- extent of the damage uncovered including photographs, notes and reports from other experts
- costs and extent of any betterment undertaken for the owner

- records of laboratory testing of timber for decay or sampling of air for mould spores
- minutes of meetings and other related contractual documents.

Designers need to be aware there will be a level of scrutiny of both the design and costs associated with a remediation project if the owner seeks compensation from other parties such as the original designer and/or builder or the local territorial authority.

2.6 Duty of care

Professional designers should always exercise reasonable skill and care when carrying out design work. While a designer can seek to contractually limit their liability, a designer should be aware that they cannot completely contract out of all their statutory obligations under legislation such as the Fair Trading Act 1986. A designer may also be subject to professional obligations administered by the New Zealand Registered Architects Board or a similar organisation.

3 UNDERSTANDING THE BUILDING

Before any remediation design options can be considered, an understanding of the current condition of the building is necessary.

Information sources include:
- the owner and Building Consent Authority (BCA)
- diagnostic reports
- site inspections
- additional specialist advice where required.

3.1 Information from the owner and BCA

Information that can be gathered directly from the owner and BCA may include:
- observations of moisture ingress
- the property file from the BCA, which may include:
  - the issue/non-issue of any Code Compliance Certificate from the original consent or any previous repairs
  - any notice to rectify and the reasons/concerns identified
- details of repair work already undertaken.

3.2 Building diagnostic reports

The key to understanding a building's condition is a diagnostic report from a specialist weathertightness assessor. The report should be discussed with the author if possible. (Note that this is not currently possible with WHRS assessments.)

A good building assessment report should cover:
- the causes and locations of water entry
- areas of elevated moisture content in timber framing

- the extent of the weathertightness failure
- the likely level of framing timber treatment (to be confirmed once the framing is exposed)
- the likely extent (minor, localised or widespread) and type of damage (cladding, framing, insulation, lining and so on)
- whether the failure is systemic and the likelihood and extent of future damage
- changes made during the building process from the consent documents
- remediation recommendations
- cost estimate (including contingencies).

Other matters to consider when reviewing a building diagnostic report include:
- the time elapsed since the report – has the damage become worse?
- any interim repairs since the diagnostic report and their impact on ongoing damage
- structural, fire rating or drainage issues – note that some reports may only cover weathertightness issues
- the possibility that not all weathertightness faults or other defects may have been identified.

3.2.1 Where there is no diagnostic report

Where an owner approaches a designer directly without any prior investigation into the weathertightness of their building, the designer should insist that the owner commission a report from a specialist weathertightness assessor.

3.3 Site inspections

A site visit is essential to review the findings of the diagnostic report and to enable the designer to understand the building, consider design options, note areas requiring details and consider landscaping issues such as abutting fences, planting and ground levels.

The visual inspection should verify:
- landscaping and ground levels around the building
- construction detailing
- quality of workmanship
- restrictions on access, material storage, scaffolding and so on required for repair work
- any daylight angle restrictions that could limit design options where the appearance of the house is being considered
- problems other than weathertightness that may need consideration by the owner (for example, poor internal ventilation or failure of bathroom waterproofing)
- drainage and other services
- the as-built design and layout of the house.

3.4 Framing timber

From the early 1990s (and in particular after 1998) to April 2004, homes were usually constructed with untreated kiln-dried radiata pine framing. Untreated radiata pine readily deteriorates if it is regularly wetted. The decay of framing timber is often hidden until structural failure occurs or the timber is exposed during weathertightness remediation. The extent of timber decay is the main unknown factor that can impact on remediation requirements.

With timber framing that has had some level of treatment, there is difficulty determining the following:
- what treatment was actually used – this may not be what was originally specified
- where the timber was sourced from – the level of treatment may vary between different suppliers
- the amount of treatment chemical used during manufacture – testing has shown that some allegedly untreated timber actually contains some traces of boron treatment
- the level of retention of the treatment chemicals in the timber over time.

From April 2004, the Acceptable Solution B2/AS1 for Building Code clause B2 *Durability* required the use of treated timber where there was any risk of water getting into the timber frame.

The only reliable evidence of timber treatment comes from removing timber samples and having these laboratory tested for the presence of decay and treatment. The diagnostic report should provide information on timber treatment.

Section 6.2 has more information on timber testing and in situ treatment.

4 UNDERSTANDING THE OPTIONS

The aim of remediation design is to address the specific weathertightness and durability issues of the building – to fix the current leaks and damage and to protect against future leaks. Other building performance issues such as structural and fire safety inadequacies may also need to be addressed.

Remediation also offers the owner an opportunity to consider making other changes to the building to increase its amenity and value.

Options facing the owner of a leaky building will vary depending on:

- the extent and nature of weathertightness failures and damage
- the costs of different options (remediate, demolish and so on)
- their desire to improve amenity or change the look of the building or reduce risk
- the owner's ability to fund repairs
- the value of the land.

The designer needs to discuss the available options with the owner and agree which approach will be followed, as different options will have different costs.

The relationship with the owner can be complicated where a body corporate or multiple ownership is involved. Individual owners may disagree on project details or may restrict access to the work site where there is a shared boundary. Where there is more than one owner, the designer should clarify at the outset (and in the contract) who has the authority to represent all owners.

4.1 Remediation

4.1.1 Relevant Building Act 2004 requirements

Remediation involves repairs and reconstruction, which are alterations under the Building Act and so must comply with the Building Code.

The requirements of the Building Code and the need for building consent must be considered in light of each particular remediation. The guidance below sets out some factors that may be relevant to compliance with the Building Act and Building Code, but this guidance does not replace professional advice given in light of the particular circumstances.

Under Schedule 1 of the Building Act, like-for-like cladding replacement is often exempt from the requirement to gain a building consent. However, the exemption does not apply where any component or assemblies have failed the durability requirements of the Building Code (typically 15 years for claddings) or where complete or substantial replacement of any component or assembly contributing to the building's structural behaviour or fire-safety properties is required.

This means a building consent will generally be required:
- for remediation work on leaky buildings less than 15 years old
- where failure is known to have happened within 15 years of construction
- where any structural elements are being replaced due to leaks (for example, decayed timber framing)
- where repairs are being made to fire separations in non-detached houses.

Because repairs and reconstruction are within the definition of 'alteration', section 112 of the Building Act requires that, following the alterations, the building needs to comply as nearly as is reasonably practicable with the provisions of the Building Code that relate to:
- means of escape from fire
- access and facilities for persons with disabilities.

Also, with alterations, all building work must comply with the current Building Code, and the rest of the building must continue to comply with the other provisions of the Building Code to at least the same extent as before the weathertightness failure.

The provisions for access and facilities for people with disabilities do not apply to private houses, and special requirements for detached houses relating to fire safety are essentially limited to the installation of smoke detectors. Non-detached houses will have other issues such as fire separations.

The designer may be faced with the question of whether repairs that are building work are required to meet performance levels specified in the Building Code where these are higher than the level that was required when the original building consent was issued (such as H1 *Energy efficiency*).

The Department provided some advice on this issue in *Codewords* 32 (October 2008). Generally, repairs to an existing building do not need to be upgraded to meet the current H1 requirements (although the owner may choose to do this). However, the particular circumstances need to be considered, particularly if the repairs have the effect of lowering the thermal resistance of the building. Also, if the repairs involve extensions or additions, these parts of the building will need to comply with the latest H1 performance level.

As each remediation project is different, the designer should discuss their proposed solution with the BCA and/or seek legal advice.

4.1.2 Improvements

In some cases, owners may wish to explore options that go beyond the minimum required to fix the weathertightness failure. This is considered an improvement and is often called 'betterment'. It is a voluntary cost incurred by the owner. Designers need to be aware that the definition of what is betterment can be contentious in claims processes.

Where a change from the original design is required to resolve the weathertightness problems with a building, this may not be considered betterment.

In some cases, some aspects of remediation designs may appear as improvements when considered in isolation but may actually allow for a more cost-effective overall solution. Also, for some remediation projects, the actual remediation work proposed can trigger a need to modify an aspect of building performance that must be included as a direct remediation cost. An example of this is where direct-fixed EIFS cladding needs to be replaced by EIFS installed on a cavity because of the extent of decay in the timber framing. The reason is that the R-value of the original direct-fixed EIFS has been diminished by the addition of a cavity, and the insulation within the framing must be upgraded to compensate.

Improving amenity and changing the appearance of a building are discussed in section 4.6.

Designers need to use their professional judgement in deciding on a repair strategy, and the reasoning needs to be documented. As the repair process starts and more information on damage becomes available, the remediation design may need to be revisited.

4.1.3 Structural issues

The design must deal with any structural elements that no longer comply with the Building Code or were incorrectly designed or installed originally and constitute a risk to safety. It must also consider structural elements that may currently meet loading requirements but are likely to fail within the required durability periods of the Building Code. This can include timber with the onset of decay or rusting steel members.

As a general rule, if the building has either untreated timber framing or timber framing with low levels of treatment, extensive leaks and decay (particularly with direct-fixed monolithic claddings), all the cladding will need to be removed to assess timber damage, facilitate replacement of decayed timber, treat any remaining sound timber and remove any hazardous mould spores. See Section 6.2 for more details on timber assessment.

It is important to allow materials that have become wet but are still sound to dry before they are closed in. In some cases where time is critical, it may be more practical to replace timber that is wet than wait for it to dry.

4.1.4 Fixing the leaks

To be effective, the remediation design must address all of the points of water entry. It must also consider details that are not yet leaking but are likely to do so within the required minimum durability periods. For example, if six windows are already leaking due to the absence of flashings, what is the likelihood that the remaining 10 windows (also without flashings and with similar levels of installation workmanship) will also leak before the minimum 15-year durability typically required for windows and claddings. Section 7.2 has more information on windows.

A successful remediation is unlikely if the design simply repeats the original details that previously failed, and it is highly probable that a BCA would not accept them. Details that are not working or are too difficult to reliably get right on site will need to be redesigned.

The designer should consider removing very complex design elements to lower weathertightness risk (see sections 4.1.6 and 4.6).

4.1.5 Ground levels and drainage

Ensuring that ground levels and surface water drainage are adequate is essential before starting any remedial construction work.

It is often more economical to use nibs to raise the framing than reduce grounds levels where services are shallow.

Weathertightness remediation may involve changes to roofs and membrane-covered decks requiring the addition or relocation of downpipes and connection to the stormwater system. These need to be considered early in the design process.

Section 7.1 has more details on ground clearance.

4.1.6 Balancing weathertightness risk

Unlike a new design where the designer has the freedom to manage weathertightness risk by choice of design and materials, in remediation, there will always be restrictions due to the existing structure, materials and design features.

A remediation design must therefore work within these limitations and still achieve a design that delivers weathertightness. It is useful to think of the 4Ds – deflection, drainage, drying and durability – when considering design options. (See Appendix 1 for more information on the 4Ds.) The risk matrix in E2/AS1 is also a useful design tool.

If the effectiveness of one or more of the 4Ds is compromised by the original design or the consequences of leaks, increasing the effectiveness of the remaining Ds will help reduce the risk of a subsequent failure of the building. Some examples of how the effectiveness of the 4Ds can be increased include the following:

Deflection
- Adding eaves or verandas to protect the wall surfaces from wetting.
- Roofing over or building in waterproof decks.
- Repitching a flat roof with a change of roof cladding.

Drainage
- Adding a drained and vented cavity.
- Replacing windows with raked and curved window heads or sills.
- Adding additional downpipes to flat roofs or decks.

Drying
- Adding a drained and vented cavity.
- Specific design of a cavity to increase ventilation rates (expert advice should be sought).

Durability
- Replacing untreated timber with suitably treated timber.
- Applying on-site treatment to remaining unaffected timber.

Other design changes can reduce the complexity of the envelope and reduce the risk of water entry through junctions that are difficult to build. Examples include:
- removing cantilevered membrane-covered waterproof decks
- changing the cladding type
- removal of parapets
- simplifying complex multi-pitch roofs
- removing pergolas and other structures attached to the building through the cladding
- avoiding penetrations through membrane-covered decks
- adding eaves or verandas.

4.1.7 Localised repairs

In some situations, it is recognised that repairs that only address a specific failure (such as the omission of a stop-end to an apron flashing) may still deliver a weathertight solution (for example, where timber framing is proven to have acceptable levels of treatment and there are only isolated defects, leaking and damage).

Designers proposing these options need to be aware of (and ensure their client is also aware of) the risk that further damage may be found during repairs necessitating a substantial redesign and a significant increase in the costs to the owner. Also, any defects not identified and repaired during the remediation process will continue to cause deterioration necessitating further remediation at some point in the future. Unless the designer manages these risks carefully, the designer could find they are involved in further claims made by the owner.

Advice from a specialist remediation expert should be sought when considering whether a localised repair is appropriate.

4.2 Demolition

Demolition may be a cost-effective solution where there is significant and widespread damage as it may be easier and cheaper to start from scratch rather than try to repair the building.

The advantages of demolition are that:

- the problem is gone
- it creates the option of selling the section or having a new home built on the site
- the design can cater for a layout that suits the owner's needs or can be smaller scale to meet a budget.

4.3 Doing nothing

Presented with an expensive repair plan, an owner may choose not to proceed with any remediation option and do nothing to the building.

The designer should inform the owner of the risks in doing this and advise the owner to seek further advice. The risks of doing nothing include:

- the building condition is likely to continue to deteriorate and may become unsafe
- the building may eventually be declared unsafe by the local territorial authority, which can then require work or demolition at the owner's cost
- potential exposure of the occupants to health effects from a damp mouldy environment
- the owner will need to advise a new buyer of the problems affecting the saleability of the property.

Ultimately, the owner may have no option if they cannot afford to carry out the repairs, despite the risks associated with doing nothing.

An owner may also decide to sell the building 'as is'. While the owner may have to accept a lower sale price, selling may be a more affordable option than undertaking repairs.

4.4 Temporary repairs

Temporary repairs may be desirable to slow or limit further damage until a decision can be made on the remediation option. They may also be useful to show a proactive response by an owner where a claim is being made for repair costs. However, temporary repairs can be problematic. The nature of the temporary repair may mean that the repair work may not be capable of complying with the Building Code, and all building work must comply (even if exempt from the requirement to obtain a building consent). Careful consideration should be given when carrying out temporary repairs, and it may be advisable to discuss proposed temporary repairs with the BCA.

If a designer is assisting an owner with temporary repairs, the designer must ensure (and include in their contract) that the owner understands that temporary works do not constitute a remediation solution.

Unless properly targeted at the actual causes of water entry, the problem may be worsened by temporary repairs, particularly applying a membrane coating over monolithic walls, which may trap in moisture. It is advisable to seek specialist advice from a remediation expert.

Temporary repairs may also obscure or destroy evidence of the original defects, so accurate records of the original condition should be kept.

4.5 Other building defects

Other building defects may be identified during the initial building assessment or during remedial construction work. Examples of these are:

- leaks from internal wet areas
- acoustic and fire separation issues in apartments and multi-unit buildings
- lack of structural performance of framing, lintels, floor joists, deck joists and bracing
- inadequate internal and external barriers (or no barriers where there should be)
- lack of handrails
- unsafe electrical installations
- plumbing leaks
- damp subfloors in buildings with suspended timber floors due to ponding of water and/or a lack of subfloor ventilation or poor drainage.

While these are not weathertightness issues, if they pose a risk to safety, they will need to be addressed. The owner should seek legal advice about how such items affect any claims they are making or may make in the future.

4.6 Design changes

4.6.1 Improving amenity and value

The designer should explore with the owner the opportunity to undertake additional work while the house is being remediated for weathertightness. Options can include:

- improving insulation levels
- replacing single glazing with double glazing
- remodelling a bathroom or kitchen
- adding a room or en suite bathroom.

Because such additional work is a voluntary improvement, there is likely to be a requirement to cost the additional work separately from the costs of remediating weathertightness problems if the owner is making or may make a claim in the future. Further advice should be sought to clarify this.

4.6.2 Changing appearance

Weathertightness problems are more common with certain house styles – particularly multi-storey houses with complex designs and direct-fixed monolithic claddings. As a consequence, there is a market perception attached to these houses that may reflect in lower resale prices.

Options to change the cladding type and or elements of the building design should be considered, for example, using weatherboard instead of a plaster-type finish (Figure 4.1).

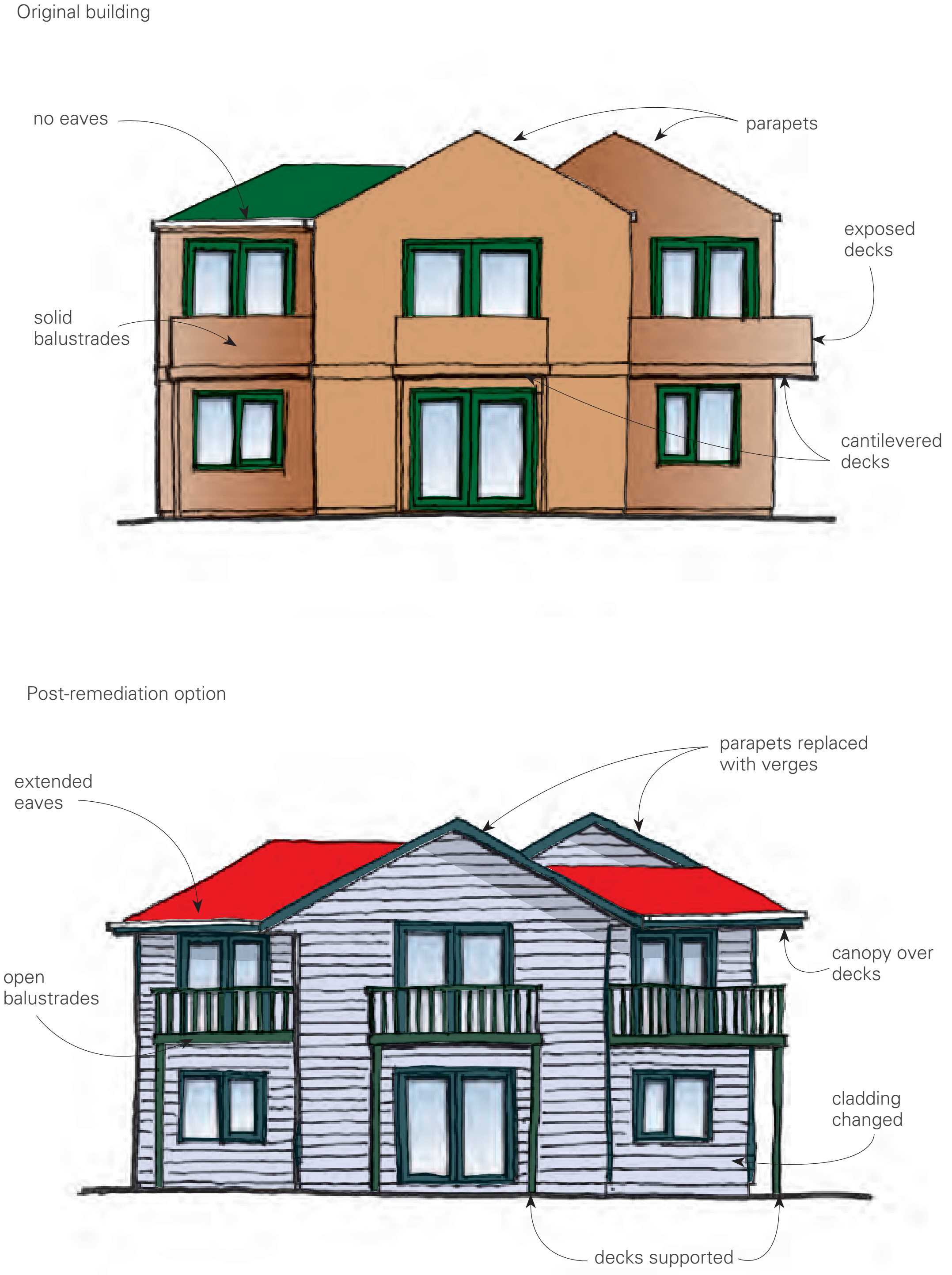


Figure 4.1 An example of typical appearance and form changes.

Other options to lower risk during the design process include:

- removing parapets
- adding roofs over decks
- removing cantilevered decks
- removing or replacing windows with curved and raked heads
- removing pergolas and other features installed with penetrations through the cladding
- repitching low-slope roofs.

Design changes to alter the building's appearance require confirmation that:

- the structure of the building can accommodate the proposed changes
- the owner understands the changes and the visual impact they will have
- the owner is prepared to pay any additional costs.

Changing the appearance may also impact on resource management issues. These are not covered by this guide, and the owner and designer should seek advice from the relevant Territorial Authority.

5 DESIGN CONSIDERATIONS

5.1 The remediation team

The specialist nature and uncertainties inherent in remediation design work mean that a range of expertise is needed.

The approach should be collaborative and will generally require input from:

- a remediation expert
- a quantity surveyor (depending on the complexity and scale of the project)
- a structural engineer.

Other specialists such as a fire engineer may need to be consulted depending on the situation. Advice from a builder experienced in remediation work can also be very beneficial.

It is advisable to discuss proposed design solutions with the BCA. Resolving design concerns at the preliminary stage is preferable to having the BCA reject a building consent application because it is not satisfied the solution will comply with the Building Code, for example, by clarifying whether the BCA has any specific requirements for identifying timber that needs replacement or peer reviews of high-risk (as per E2/AS1 risk matrix) designs.

The monitoring of the construction process should be undertaken by a member of the remediation design team. The owner should be kept fully informed of progress and any issues arising.

5.2 Preliminary design

The purpose of preliminary design is to:

- explore with the owner what the repaired building can look like

- enable initial cost estimates, including contingencies, of the preliminary design
- agree a design.

A quantity surveyor can be engaged to provide initial indicative costings of the options being considered.

Known high-risk features and areas of difficulty should be focused on and, where possible, redesigned. It is good practice to circle all junctions and abutments to check that the remediation design solution has taken them into account.

5.3 Developed design

Developed design is where the preferred design option is investigated in detail.

To enable estimated costs to be firmed up, the developed design should address:

- the agreed extent of work including improvements and prioritisation of the work – staging work can increase the overall cost of the repair because of the additional set-up costs for each of the stages
- selection and detailing of materials and finishes
- areas of the project that are difficult to detail.

Particularly when new to this type of work, designers should also consider getting remediation documents peer reviewed by a designer experienced in this type of work or a remediation specialist.

5.4 The building contract

A key part of any building project is the contract, which defines the roles and responsibilities of the parties to the contract – primarily the owner and the builder. The designer may also be a party to the contract, or the designer may have an obligation under their own contract to monitor the building work. All parties should seek independent legal advice on the terms of the contract.

The owner may chose to appoint the builder through a tender process or by negotiation. The owner should seek legal advice on which is most appropriate in their circumstances.

Where the builder is appointed through a tender process, before the remediation work is started, it is recommended that the designer provide those tendering with a schedule of conditions outlining the existing state of the property or adjoining properties that may be affected by the proposed remediation project.

Alternatively, if the builder will be chosen and the contract negotiated, it may be advantageous for the builder to be appointed at an early stage and involved in the design process to provide insight on the buildability of the proposed design.

Most standard industry contracts available can provide a good starting point for the building contract. General conditions of contract can be based on a recognised standard form, such as NZS 3910 *Conditions of contract for building and civil engineering construction* or those from engineers' or architects' professional bodies.

However, contract documentation for remediation projects should be specific to the remediation work and tailored to the particular circumstances. The contract should ideally provide flexibility around the work being undertaken, particularly in regard to potential uncertainties.

The list below sets out some matters that may need particular consideration in the context of leaky home remediation. This list is not exhaustive, and the circumstances of each remediation need to be considered at the time and legal advice should be obtained.

- Staging: Should the work be staged (particularly if the building is a multi-unit dwelling or if the owner intends to live in the house while the work is carried out)?
- Further diagnosis: Who will be responsible for further diagnosis of the damage once the framing is exposed? What will the process be?
- Additional work: If further diagnosis shows that additional remediation work is required, how will the further work be agreed and costed?
- Insurance: Who will take out the necessary insurances, how much insurance will be taken out and what type of insurance is required (for the building and contents, the works, the materials and any public liability or professional indemnity insurance)?
- Access: If there will be restriction on access, when will the builder have site access and will there be any specific restrictions when working on a site? Particularly consider multi-unit dwellings, neighbours and circumstances where the owners will remain in occupation during the works.
- Quality assurance: Is a QA programme required? Who will monitor this?
- Owner occupation: Is the builder to provide access to facilities such as toilets and kitchens?
- Protection of existing property: Does the contract need special provisions for the protection of existing buildings (including security), vegetation and neighbouring properties?
- Health and safety: Consider specific health and safety requirements such as dealing with toxic moulds.
- Unforeseen issues: Consider procedures for dealing with unexpected issues that are identified during construction.

Contract documentation should also identify what is expected to be provided to the owner on completion of the remediation work and whose responsibility it is to provide it.

5.5 The cost

An accurate cost estimate is not possible before the full extent of the damage is known.

Cost estimates and contracts for remediation work should include provisional sums for undefinable work and an overall contingency.

Close monitoring of costs through construction allows the expected final cost to be regularly updated. This supports informed ongoing decision making about any changes to the remediation scope/design where damage is shown to be more extensive than anticipated.

The designer's contract should allow for additional fees for the construction observation phase. While the initial design documentation requirements are much the same as other design work, there is generally a higher level of on-site monitoring/construction observation, with associated client and site meetings, required in remediation projects, and variations to consent documents are highly likely.

5.6 Code compliance

The remediation design documentation will need to demonstrate to the BCA that the proposed building work will meet the Building Code (see section 4.1.1). The owner and designer may also need to consider local planning requirements and the Resource Management Act – these matters are not covered in this guide.

Significant variations to the original building consent documentation resulting from the discovery of more damage during remediation work should be discussed with the BCA to ensure that these are approved by the BCA and recorded in the project file.

6 CONSTRUCTION CONSIDERATIONS

6.1 Communication

As with all projects, communication with the owner and between the design team members and the builder is essential to the smooth running of the project. Communication involves keeping everyone informed about progress and issues arising, as well as seeking input when making decisions.

Appropriate site responsibilities must be defined, including the appointment of a representative for on-site observation throughout the construction. These details should be included in the relevant contracts.

The number and frequency of meetings will be determined by the size and complexity of the project.

Developing a relationship with neighbours is also essential – access may be required through adjacent properties or works may impact across the boundary.

Talking with the client is a key part of managing their expectations – they need to understand that things will not be straightforward with remediation work. Attendance by the owner at site meetings is beneficial in keeping them fully informed of progress and issues.

The project file and documentation underlies and supports good communication and should include:

- records of what has happened and what future work has been agreed (meeting minutes, site notes, variation orders)
- a photographic record of the remediation work, especially as damage (or otherwise) is revealed.

As noted earlier, a claims process may be in progress even while remediation repairs are under way. This adds further importance to the need for good communication, information sharing, record keeping and scrutiny of the work. All records will be made available to 'other parties' in a legal claim through a process known as discovery.

6.2 On-site monitoring/construction observation

The importance of on-site monitoring of progress or construction observation is heightened with remediation work. As the project progresses, additional information on the condition of the building will come to light, and the context and scope of the work may change.

As the removal of building elements or materials progresses, the condition of those materials must be evaluated. This information is essential in order to assess whether any changes need to be made to the agreed remediation design.

Once cladding is removed, an assessment needs to be made to determine:

- any timber framing that must be replaced
- where samples need to be taken to test for timber decay and treatment
- timber needing in situ treatment
- any internal linings that need replacing and impacts on bracing resistance
- whether internal fittings, such as, kitchens, need to be removed to allow replacement of framing or linings
- insulation that needs replacing due to damage or mould contamination
- whether the sources of moisture entry have been correctly identified.

This may result in:

- redesign of a proposed solution where the original detailing cannot be applied to the specific conditions identified on site
- a variation to the building consent and/or to the contract to remedy faults that must be repaired.

It is also important that the builder arranges BCA inspections at appropriate points during the project.

6.2.1 Timber testing

Taking samples for laboratory testing of timber is essential because it is not possible to determine from visual observations or by limited on-site tests whether decay fungi have infected timber. Also, timber can have surface mould that looks like decay fungi and yet be sound.

The selection of areas of framing for testing should be under the direction of the remediation specialist on the team.

The testing of existing timber for rot, fungi and evidence of existing levels of treatment must be carried out immediately after the cladding is removed. Delays before testing reduce the reliability of the results, and rapid air drying can change the surface appearance of timber, making it difficult to visually confirm the presence of decay. Generally, timber is marked up for removal and the testing used to validate the decisions of the remediation specialist.

Testing should be carried out on an ongoing basis. This will determine the level of timber treatment present and the likely extent of the timber damage.

6.2.2 Dealing with decay

The key to dealing with decay is to provide a dry future environment for framing timber.

While the building assessor's report can help determine the extent of decayed timber, the full extent can only be determined once the cladding has been removed. This section provides the designer overview of dealing with decay but is not a substitute for advice from an assessor or remediation specialist.

Timber that is shown by testing to have lost strength as a result of decay must be cut out and replaced. Experienced remediation specialists advise that it is better to err on the side of caution when replacing untreated timber framing.

For wall framing, it is generally easier and more cost-effective to remove and replace the affected members rather than try to cut out the rot and flitch in new framing. As a rule of thumb, it is considered more economic to do a total replacement where more than 30–40% of the timber is affected by rot. NZS 3604 does not allow the jointing of studs, so any rot-affected studs need to be replaced.

During replacement:

- existing timber framing must be supported as required until the new framing is installed
- replacement timber should be treated in accordance with Acceptable Solution B2/AS1 for its location in the building
- dry storage should be provided for replacement timber.

Where wall framing damage is extensive, the repair will also require the replacement of internal linings, internal trims, insulation, wall underlays, wiring and plumbing pipes.

It may also require the demolition or removal of kitchen fittings, bathroom fittings, windows, floor coverings and wet area internal linings to allow existing timber to be removed and new timber installed.

Floor joists that are affected by decay need to be cut back to the point where the strength loss ceases to occur. A rule of thumb is to cut back into sound wood at least 1.0 m from the point where the limit of decay is detected. This distance can be reduced by testing samples for decay taken at, say, 300 mm increments along the joist.

Where there are boundary joists, the visible face exposed after the cladding is removed may appear sound, but it is common for deterioration to occur between the outer and inner joist, which can be difficult to detect.

Depending on the design of the building, it may be possible to insert a new beam within the floor space to support the remaining length of joist and the replacement joists, usually utilising joist hangers (Figure 6.1). This will require specific engineering design.

The amount of timber that needs to be removed may vary between units in a multi-unit development or between rooms in a single dwelling (Figure 6.2). Boundary joists that are damaged will usually need to be treated in the same way.

Sound timber adjacent to that removed that is not adequately treated must be treated with a paint-on treatment (see 6.2.3).

6.2.3 Site treatment of timber

Timber that is untreated or has low levels of treatment and no damage that is exposed during remediation should be site-treated to improve future long-term durability.

Two common products that are available and widely used are:

- boron in glycol
- copper naphthenate in solvent.

An advantage of site treatment is that not only does it help protect timber that is untreated or has low levels of treatment, but it can also limit the progression of decay in the very early stages of development before timber strength is affected. However, it will not restore strength

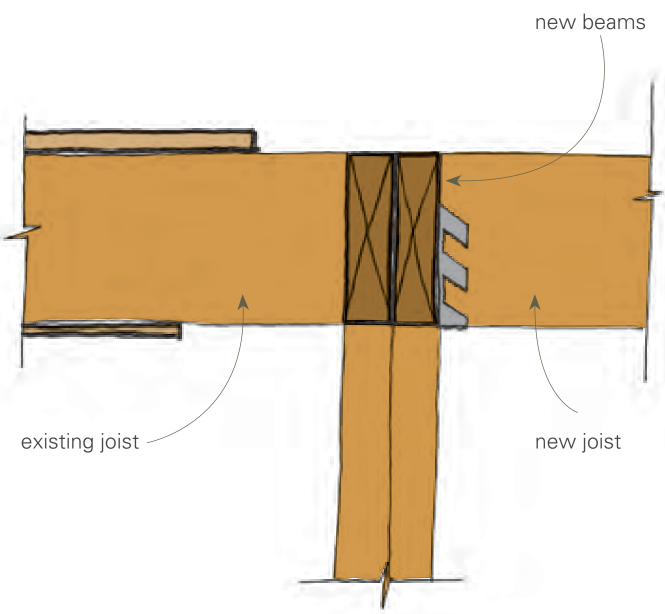


Figure 6.1 Replacement of part of mid-floor joist with a new support beam.

to damaged timber. Testing in recent years has shown good performance of boron in glycol solutions brushed onto untreated timber at manufacturers' recommended rates. Testing (including ongoing research commissioned by the Department of Building and Housing) shows that at least three sides of the framing need to be accessible for best results.

One area of difficulty is construction involving multiple or laminated framing members (Figure 6.3) where the members in the middle are affected by rot but the two outside members are sound. In these cases, it is only possible to site-apply treatment chemicals to a small part of those members in the middle of the lamination, which will be of limited use in preventing further deterioration. In these cases, it is recommended that all of the affected built-up timber is removed and replaced.

Advice should be sought from the testing laboratory on the suitability of applying the treatment or whether the timber needs to be replaced.

The primary aim of remediation is to restore the weathertightness of the building envelope. Site-applied treatments (and new treated timber) will not reliably prevent decay over the medium to long term if the timber continues to be exposed to high levels of moisture, i.e. in excess of 18% and particularly 25% moisture content. In some cases, decay already present can reactivate at moisture contents as low as 20%.

6.2.4 Dealing with non-decay fungi – moulds and sapstain

Mould and sometimes sapstain (blue stain) fungi can be found on many building materials in the presence of high humidity but are usually present where any material containing cellulose (timber, fibre-cement, kraft-based building paper or plasterboard) is wetted.

Figure 6.2 Two photos showing the difference in extent of floor joist removal in adjacent units in the same complex.

Figure 6.3 Floor beam that has been laminated on site from a number of floor joists where the centre members are affected by rot.

While many do not pose health risks, *Stachybotrys atra* or *S. chartarum* and some other types of mould can affect the health of occupants and contractors working on the site. Spores that can become lodged in the respiratory system are more likely to be released if mouldy materials have dried out before handling. Air sampling is necessary where spores may have been disturbed and become airborne.

To minimise the risk:
- work should be undertaken from the outside if possible
- workers should wear protective gear if mould is present
- where internal work is necessary, that work area must be isolated from the remainder of the dwelling and placed under negative pressure.

The contracts with the designer and the builder should include provisions setting out what will happen if mould is uncovered and how it is to be dealt with.

6.3 Site conditions

Remediation projects are generally dealing with an existing building within developed surroundings with limited space to work in, which adds to the complexity of the project. In addition, the building may be occupied while the remediation works are undertaken.

Occupation is discouraged because it is difficult to ensure the health and safety of occupants in the midst of a construction site. Other issues include loss of privacy, noise and dust.

The costs of remediation are also higher because the builder has to work around the occupants and will often have restricted working hours. The additional costs often exceed temporary accommodation costs.

Specific site conditions that may need to be addressed include:
- availability of clear space around the building when scaffolding is required
- space for storage of new materials, builders' cabins and workspace or materials for disposal
- ability to temporarily weatherproof the building once cladding is removed
- security of the site and the building (particularly if scaffolding is in use) to prevent any unauthorised entry
- access from, and overlap into, adjacent properties
- protection of adjacent properties from damage and nuisance.

6.4 Sequencing of work

The builder's work plan should outline critical points in the programme, for example, a completion date for removal of cladding so testing of timber for decay can be done before timber removal starts.

6.5 On completion

On completion, the owner should be given:
- the Code Compliance Certificate (the owner and builder should agree who will request the CCC from the BCA)
- final as-built drawings
- contact details for the main subcontractors
- warranties and guarantees
- technical instructions and data sheets
- a customised maintenance plan.

6.6 Ongoing maintenance

A customised maintenance plan enables current and future owners to know what ongoing maintenance is necessary for preventing future weathertightness problems and maintaining manufacturers' guarantees. It can provide specific guidance on the areas to inspect, what to look out for and the resulting maintenance actions/regime required.

It might also include recommendations that the owner budget for future replacement of items that are not affected by the remediation but are more than halfway through their expected life.

7 REMEDIATION DETAILING SOLUTIONS

Section 4 briefly describes the options that are available when considering the remediation of a leaking building. This section covers some design concepts to stimulate designers' thinking.

7.1 Dealing with inadequate ground clearance

One common problem is that the base of a wall and therefore the wall cladding is too close to the outside ground level, paving or the finished surface of a deck. In some cases, the outside level is higher than the floor level inside (Figure 7.1).

Remediation options where outside natural ground levels are too high include the following:

- Excavating to lower the level and slope the ground away from the building (the preferred option). Specifying that ground levels be lowered (where required) before remediating wall cladding is recommended, as it makes the cladding remediation easier and less liable to damage. The depth of underground services needs to be checked to see if this is viable.
- Removing the cladding, the bottom plate and a portion of the bottom of the wall framing and forming a concrete nib on the slab (Figure 7.2).
- Providing drainage channels. Note that, to be effective, drainage channels must be cleared.

Figure 7.1 The set-out of the slab levels for this building means that the finished slab is below the natural ground level around half of the building perimeter.

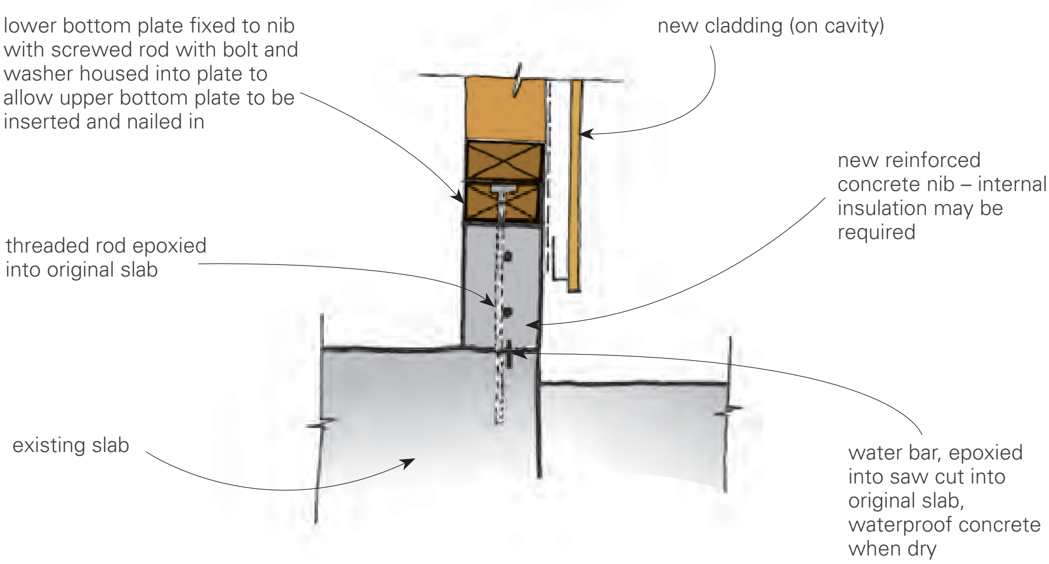


Figure 7.2 Nib detail with double bottom plate to lift base of wall.

Wall cladding must be installed so that it is clear of surrounding surfaces, whether natural ground, paving, waterproof decks or flashings. This is necessary for many claddings to ensure the durability of the cladding and framing along the bottom of the wall, particularly for claddings installed with a cavity, to ensure drainage can occur and that the relative humidity of air entering the cavity is not too high.

One area of concern that may require addressing is where the base of the cladding finishes immediately above or within a damp space such as below a timber-slatted deck, particularly where a drained and vented cavity is installed. In these situations, consider terminating the cavity above the deck where the environment is drier to minimise the risk of moist air being drawn into the cavity or adding drainage channels around the base of the wall.

7.2 Dealing with windows

Where cladding is being removed and framing replaced, it is likely that the windows will also be removed.

Options are to reuse the windows or replace them with new joinery (possibly double-glazed if the client is prepared to pay the additional cost). The option of replacing windows that have shapes that are difficult to weatherproof, such as those with curved or raked tops or raked bottom edges, with rectangular windows should be considered.

Before windows are reused, their condition will need to be assessed to see if they are weathertight, and the owner may need to contract a window specialist for this. If removing the windows and reinstalling them as part of a new cladding system is part of the building consent, the BCA may consider them part of the consented building work and ask for evidence that the windows will perform for the 15 years following the issue of the Code Compliance Certificate.

Where windows require extensive work (waterproofing joints, new glazing rubbers, the replacement or modification of reveals to accommodate changes in the cladding or a cavity) to bring them back to near-new condition, it may be more cost-effective to specify new joinery because of the time involved to repair the existing windows and the costs of storage.

When removing windows with slimline jambs, there is additional cost of installing architraves as the plasterboard has to be cut to allow the windows to be removed. This will result in a change in appearance that should be discussed with the owner to avoid disappointment if they prefer the original look.

When detailing the windows, it is good practice to:

- ensure stop-ends are specified for head flashings in cavity systems
- apply flashing tape to the opening and incorporate air seals between the reveal and the frame
- incorporate sill tray flashings where appropriate
- ensure the requirements of NZS 4223 *Code of practice for glazing in buildings* Part 3 for human impact on glass are complied with.

7.3 Dealing with membrane decks

Membrane-covered decks over habitable spaces are a known area of problems. Any failure means that water gets into the dry habitable spaces below. As decks carry loads from the occupants, there is also the risk of injury once the supporting framing becomes damaged and the deck collapses.

In any remediation design of decks:

- ensure the deck has sufficient fall and is designed to drain to all outlets
- ensure that the substrate is correctly specified, supported and fixed

- ensure there are no fixings or penetrations through the deck membrane
- ensure an adequate step-down from inside floor levels to the deck or upstand (for example, Acceptable Solution E2/AS1 requires 100 mm)
- provide more than one outlet and overflow where the deck is contained within solid walls
- be particularly clear in detailing weathertight design of junctions and abutments.

Other useful design options include:
- removing cantilevered decks and replacing with externally supported decks
- protecting waterproof membranes from foot traffic, for example, with permeable and removable walk-on surfacing
- using open balustrades that will allow excess surface water to flow off the deck (drip edges are essential in such designs)
- providing some protection to the deck, for example, adding a roof (Figure 7.3)
- simplifying the deck layout to minimise laps and joins in the membrane.

7.4 Dealing with balcony walls

Balcony walls were commonly detailed with a flat top and finished with the wall cladding.

Handrails were often fixed through the top of the wall, and drainage was poorly detailed.

As a consequence, deterioration of framing in balcony walls and the deck and wall framing below is relatively common, and significant repair is likely to be needed.

Options that may be available include:
- ensuring handrails are side mounted, not top mounted
- flashing the top of the wall and providing a saddle flashing at all balcony wall/full height wall junctions.
- replacing the solid balustrade wall with one that is open on at least one side of the deck (Figure 7.4).

7.5 Dealing with roofs

While most of the focus of remediation design is on leaks through the wall cladding and associated features such as membrane-covered decks, parapets and windows, a proportion of buildings with weathertightness failure have leaks originating through roof cladding, particularly low-pitched membrane-covered roofs.

7.5.1 Membrane roofs

Options for repairing membrane roofs include rebuilding the existing roof with new framing, substrate and a membrane roofing system, ensuring correct detailing and installation is followed.

It is essential that the substrate is correctly specified, supported and fixed if the membrane is to perform as intended.

Providing ventilation to any roof space under a membrane roof avoids the risk of moisture accumulating between the substrate and the membrane.

Removing parapets allows external gutters to be used, lowering the risk of water entry.

Rebuilding the roof with an increased slope so long-run profiled metal can be used is another option. This requires a detailed feasibility review at the concept stage to consider:
- height to boundary restrictions
- increased structural loads

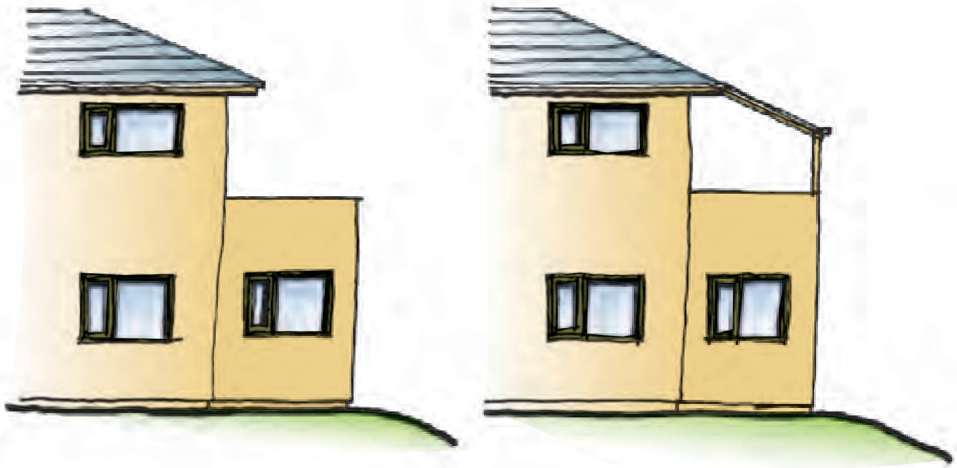


Figure 7.3 Elevation before and elevation after roof (only) added over waterproof deck.

Figure 7.4 Solid balustrade replaced to allow at least one side of the deck to be open.

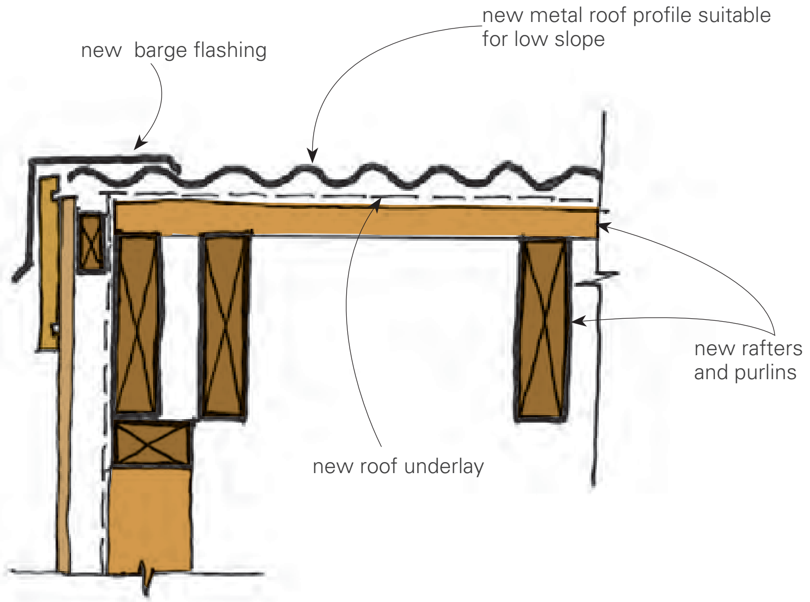


Figure 7.5 Edge detail option to a replacement roof with no parapets.

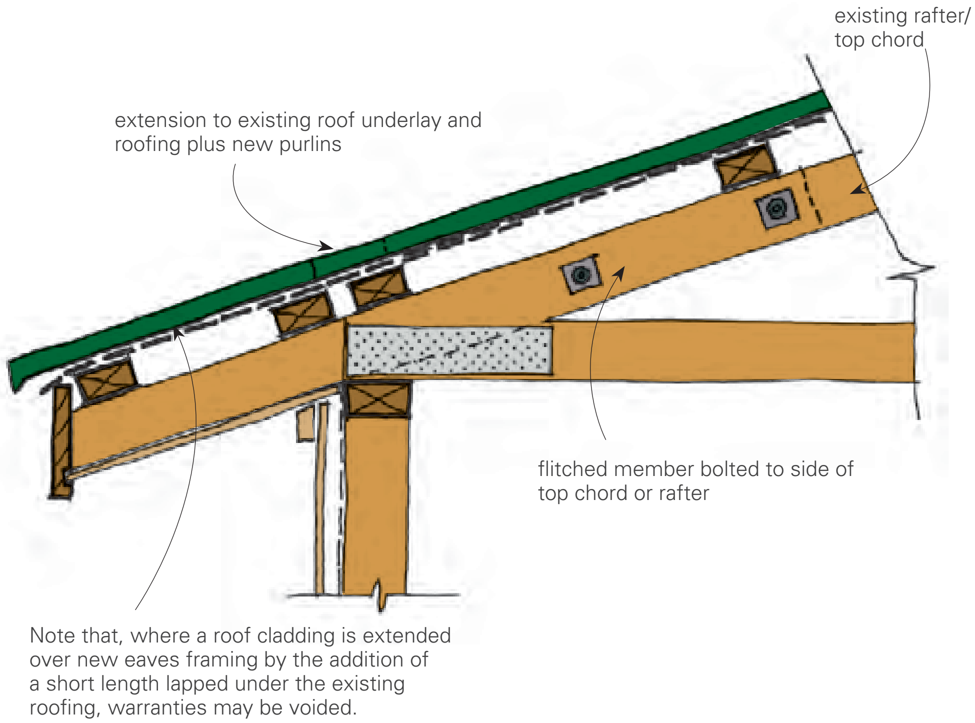


Figure 7.6 Flitching new outriggers to a truss top chord or rafter to create an eaves overhang.

- likely relocation of downpipes
- creation of a loft under the roof
- increased costs.

If there is a parapet associated with the membrane roof, this can be removed as shown in Figure 7.5.

7.5.2 Adding eaves

Many buildings can have their weathertightness risk reduced by adding eaves. Typically, pitched roofs can have outriggers flitched to the rafters or truss top chords to create eaves (Figure 7.6). Engineering advice should be sought on the extension of the rafters.

The designer will also need to consider how the additional roof cladding is to be integrated with the existing roof cladding.

7.5.3 Enclosing exposed rafters

For eaves (particularly reverse-sloped) with exposed rafters, water entry is common around the rafter where it penetrates the cladding (Figure 7.7).

These junctions – where the texture coating to the cladding is butted against rough sawn timber that moves in response to moisture changes – are almost impossible to seal.

While the repair will look different to the original, adding a soffit lining and flashing will reduce the risk of water entry (Figure 7.8). If the look of the exposed rafter is to be retained, adding a false rafter underneath is an option.

Figure 7.7 Exposed rafters with junctions that are difficult to weatherproof.

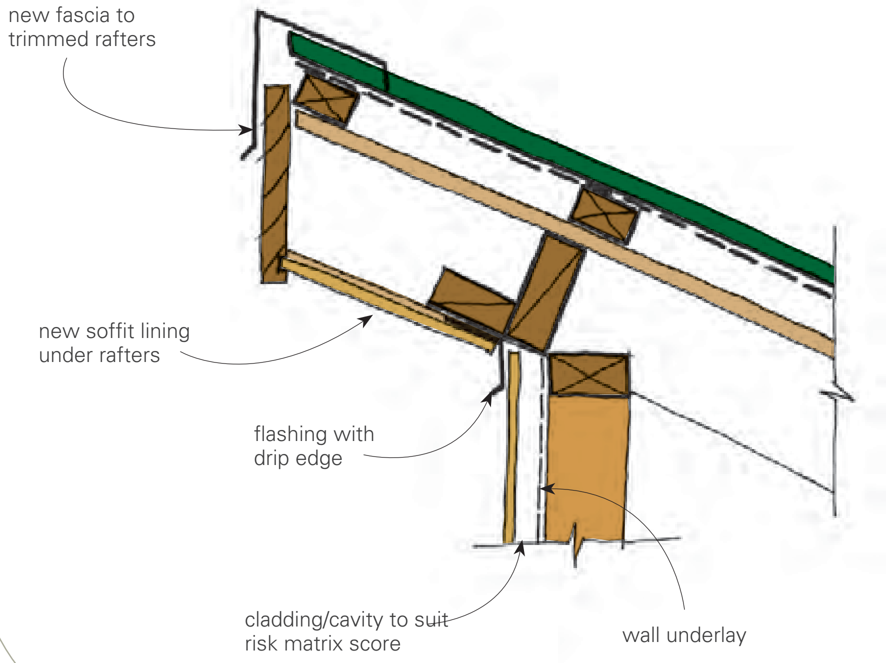


Figure 7.8 Repair option to situation shown in Figure 7.7 – while the appearance has changed, the weathertightness risk of the existing detail is removed.

Figure 7.9 Stucco cladding is vulnerable when butted up to blocking along the raking gable end of the building.

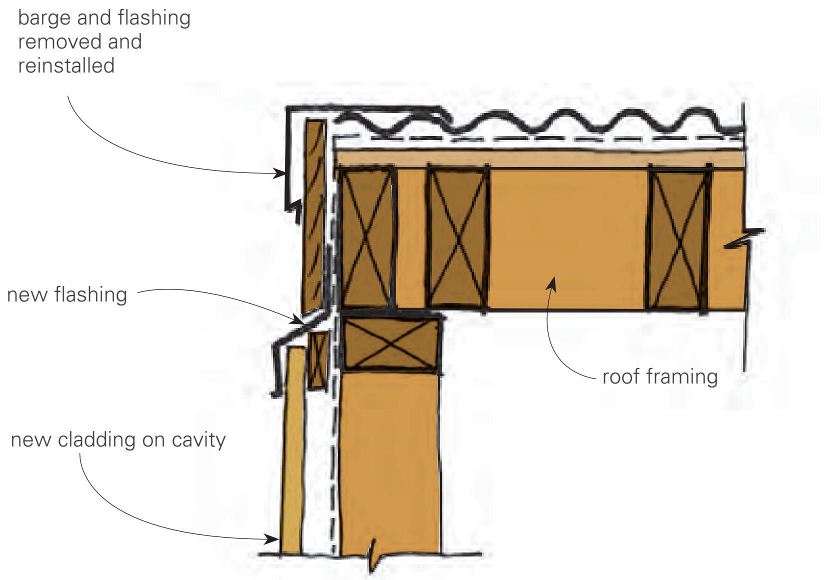


Figure 7.10 Repair option without extending the roof structure – new flashing to have 35 mm minimum lap over cladding and under bargeboard.

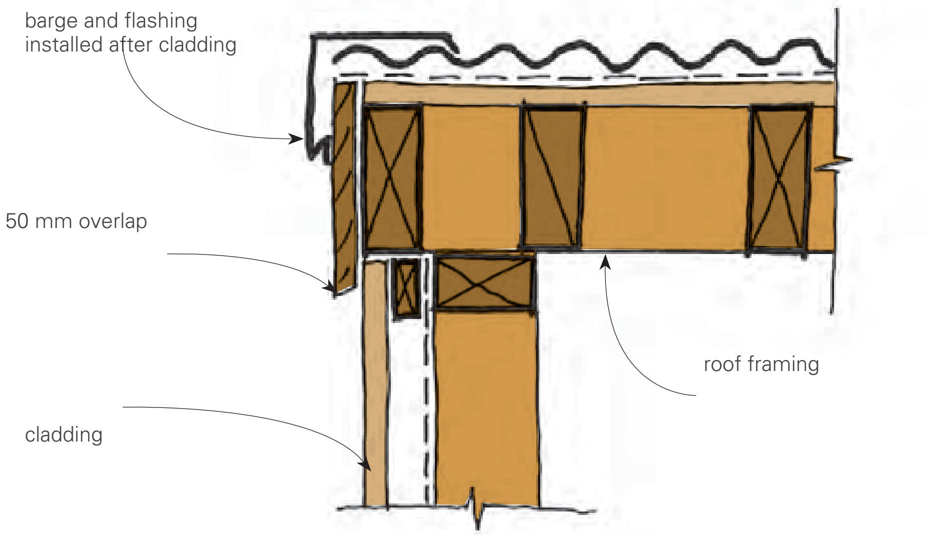


Figure 7.11 Alternative detail where roof structure is modified to allow the fascia or bargeboard to overlay the new cladding on a cavity.

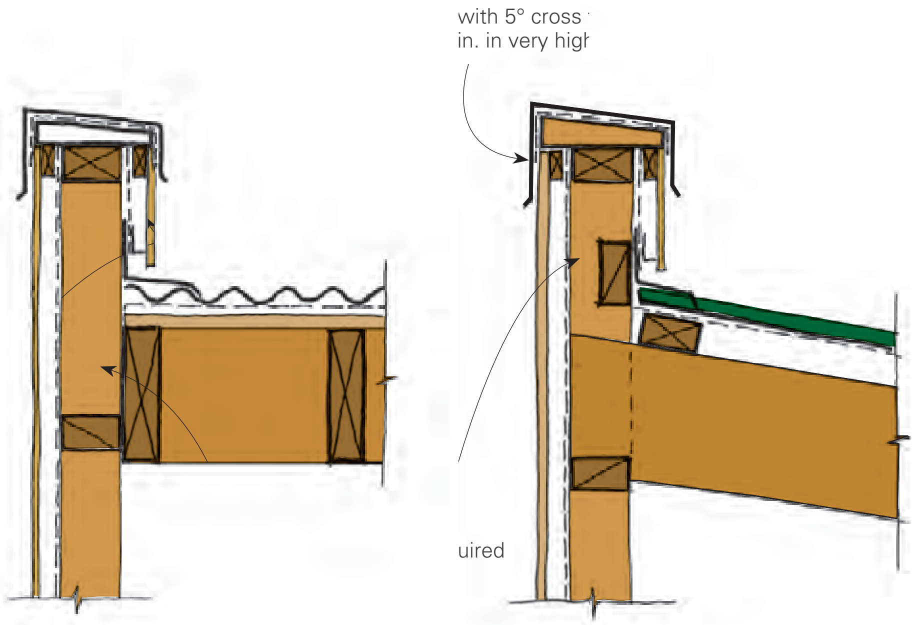


Figure 7.12 Repair options for retaining a parapet, incorporating a cladding cavity and a sloped fully supported cap flashing.

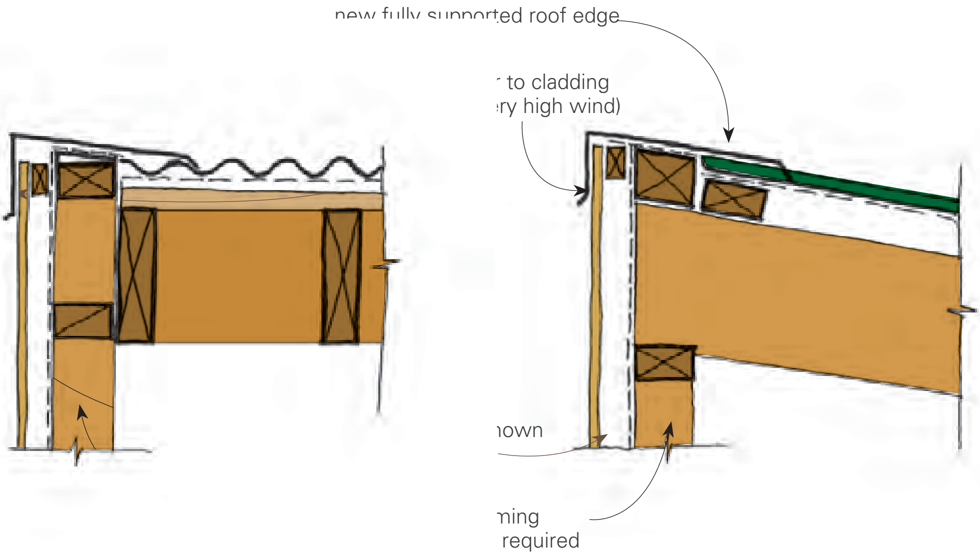


Figure 7.13 Options for removing a parapet, which also lowers the risk score (and may mean that a direct-fixed cladding as shown can be retained provided the timber framing has sufficient treatment). A similar detail can be used where the cladding is installed over a cavity – it is important that there is an air barrier between the back of the cavity and any roof spaces. The use of a wider, fully supported flashing avoids the need to inset new roofing.

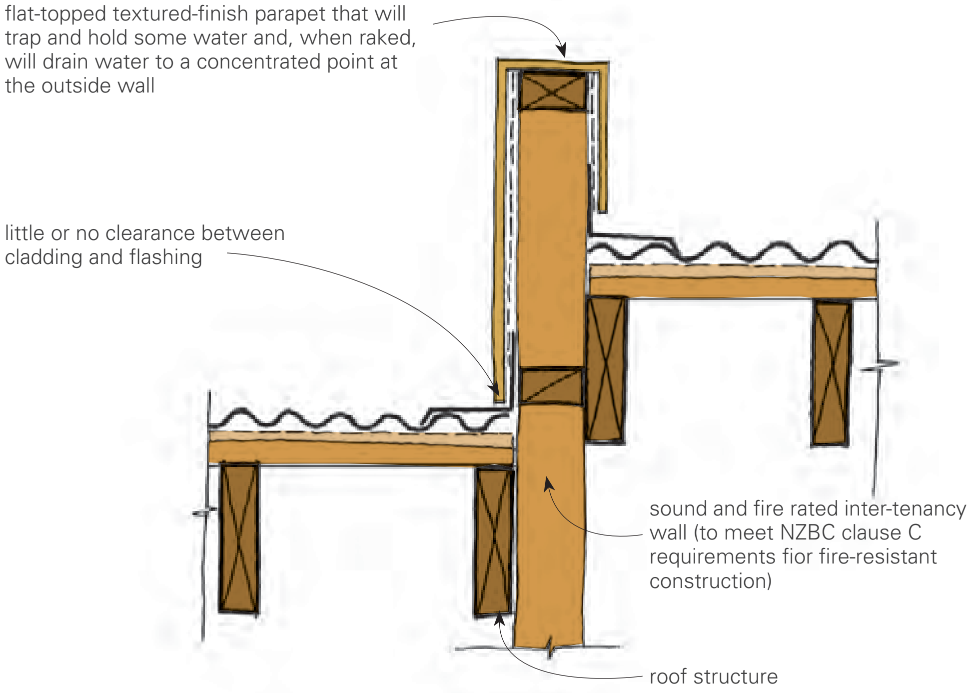


Figure 7.14 Original inter-tenancy parapet wall detail with flat textured top.

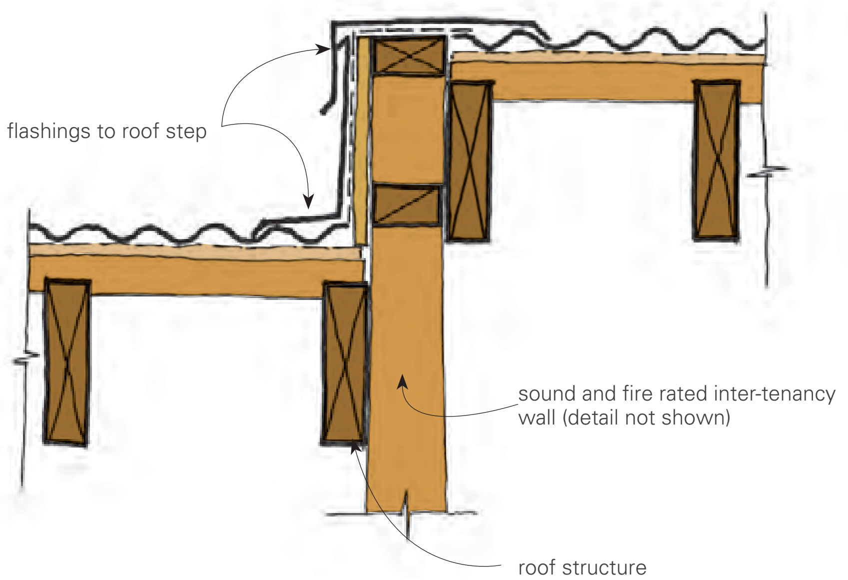


Figure 7.15 Remediated inter-tenancy parapet wall detail – parapet removed and junction flashed.

7.5.4 Modifying flush eaves

Many buildings that require remediation were built with flush eaves. It was common for a plastered finish to simply butt into a fascia or barge board, as shown in Figure 7.9, which cracked and allowed water in.

Figures 7.10 and 7.11 give two options that retain the flush eaves but modify the critical junction by ensuring deflection of water can occur.

7.6 Dealing with parapets

Parapets were commonly detailed with a flat top and finished with the wall cladding material. The texture of the cladding allowed water to sit on the surfaces, accelerating breakdown of the coating system and allowing water into the framing. Where parapets are being retained, flashing the top is considered essential (Figure 7.12).

Where the cladding system has failed and there is framing damage, cladding removal and replacement of framing will be required. This is a good time to make the decision whether the parapets should be kept or removed.

Where the roof slope is parallel to the parapet or at right angles to the apex of the roof, the reconstruction detail after removing the parapet can be relatively simple by incorporating a cavity behind the cladding and barge flashing the top of the parapet. Using a wider flashing means that the roof cladding will not need to be altered, but the flashing will need to be fully supported. Options for removing parapets are shown in Figures 7.13–7.15.

7.7 Dealing with apron flashings

Apron flashings are a common cause of water entry in leaky buildings, often because they lacked kick-outs and relied on sealant or textured coating at junctions.

Apron flashings must:
- extend up behind the wall cladding and building wrap
- adequately cover the abutting roof cladding
- provide a capillary break at the flashing/roofing junction
- have clearance between the bottom of the wall cladding and the apron
- have kick-outs where the flashing terminates within a wall.

Acceptable Solution E2/AS1 provides useful details on a range of flashings, including apron flashings.

7.8 Dealing with bracing

During remediation work, it may be necessary to remove bracing elements. This could be the plasterboard lining or cladding that forms part of the design structural bracing such as fibre-cement sheet, plywood sheet or the rigid backing to stucco.

Where existing bracing is being replaced or amended due to the remedial design no longer providing bracing (for example, a sheet cladding originally providing bracing being reinstalled over a cavity), the designer will have to demonstrate that the new design provides the same level of bracing as the original design.

As work proceeds, it may also become evident that the bracing provided by internal linings particularly or by cladding is not of the standard required at the time of construction, typically because of deficiencies in the anchoring of the panels to the floor structure. Bracing that is incorrectly fixed down may need to be replaced, or additional fixings may be able to be retrofitted.

Where bracing is being replaced, the BCA must be advised.

7.9 Adding verandas

Where allowed under district plan requirements, adding a veranda to an existing building provides benefits by:

- sheltering a large area of wall from the rain
- providing protection to critical junctions around windows and doors.

They can also be used to cover a high-risk waterproof deck structure.

Issues surrounding the addition of a veranda are:

- the structural connection to the building to ensure uplift is resisted
- support of the open side
- flashing the roof/wall junction.

8 INFORMATION RESOURCES

This section contains a list of information resources that may be useful to remediation design. It is not a complete list of all relevant resources.

Department of Building and Housing

Publications are available from the Department (free download from **www.dbh.govt.nz**) or freephone 0800 370 370.

- Acceptable Solution B2/AS1 Amendment 7
- Acceptable Solution E2/AS1 Third Edition
- Characteristics and defects – a study of weathertightness determinations (April 2007)
- Constructing cavities for wall claddings
- External moisture – a guide to using the risk matrix (2005)
- External moisture – an introduction to weathertightness design principles (August 2006)
- Guide to applying for a building consent – simple residential buildings (2007)
- Weathertightness: Guide to the diagnosis of leaky buildings (2011)

Standards New Zealand

Standards New Zealand publications are available for purchase from **www.standards.co.nz**.

- NZS 3602:2003 Timber and wood-based products for use in buildings
- NZS 3604:1999 Timber framed buildings

BRANZ

BRANZ publications are available through **www.branz.co.nz**.
Building Basics:

- Weathertightness

Good Practice Guides:
- Membrane roofing
- Profiled metal roofing
- Profiled metal wall claddings
- Stucco

Weathertight Solutions:
- Volume 1 Horizontal weatherboards
- Volume 2 Stucco
- Volume 3 Profiled metal (wall cladding)
- Volume 4 Masonry
- Volume 5 Roofing
- Volume 6 Membrane roofing

Bulletins:
- 353: Ground clearances
- 428: Weathertightness do's and don'ts
- 433: Weathertightness checklist
- 434: Results of weathertightness failure
- 435: Weathertightness evaluation
- 449: Keeping water out – timber-framed walls
- 452: Weatherproofing aluminium windows
- 456: Alternative Solutions
- 463: Aluminium windows and E2/AS1
- 465: Domestic flashing installation
- 466: Timber-framed parapets, balustrades and columns
- 467: Principles of flashing design
- 470: Wall underlays
- 481: Timber windows
- 493: Timber treatment
- 505: Acceptable plans and specifications
- 527: Drained and vented cavities

New Zealand Metal Roofing Manufacturers Association
- New Zealand metal roofing code of practice

New Zealand Membrane Group
- Code of practice for the application of torch-on membrane

Canada Mortgage and Housing Corporation
Building Envelope Rehabilitation:
- Consultant's guide: 2001
- Owner-property manager guide: 2001

Occupational Health and Safety
- Risks to health from mould and other fungi – Workplace Health Bulletin No.17 (2002)

Building Research Establishment (UK)
- Recognising wood rot and insect damage in buildings (Third Edition) (2003)

9 GLOSSARY

Acceptable Solution	Has the definition given in the Building Act 2004.
Acceptable Solution E2/AS1 Third Edition	An Acceptable Solution issued by the Department of Building and Housing for Building Code clause E2 *External moisture.*
AS	Australian Standard.
AS/NZS	Joint Australian and New Zealand Standard.
BRANZ	An independent and impartial research, testing, consulting and information company providing resources for the building industry.
Building Consent	Has the definition given in the Building Act 2004.
building envelope	The outer structure of a building (including the floor if over a subfloor space) that is covered with wall and roof claddings.
CCC	A Code Compliance Certificate as defined in the Building Act 2004.
Compliance Documents	Has the definition given in the Building Act 2004.
DBH	Department of Building and Housing.
decay	Deterioration of timber due to the action of fungi that become established within building timbers when moisture levels are elevated above fibre saturation.

defect	A particular detail or location that is either causing or contributing towards moisture penetration at present or may do so in the future.
Department	Department of Building and Housing.
Determination	A determination made under the Building Act 2004.

APPENDIX 1

WEATHERTIGHTNESS DESIGN PRINCIPLES

The key to weathertightness design is the application of the 4Ds:

1. **Deflection** – keeping water away from potential entry points.
2. **Drainage** – providing means of removing water that does enter.
3. **Drying** – allowing any remaining moisture to be removed by ventilation or diffusion.
4. **Durability** – providing materials with appropriate durability.

A1.1 Deflection

Deflecting water away from cladding junctions can significantly reduce the water load on a junction (including junctions around openings and penetrations).

Deflection achieves this by using an effective cladding and reducing the amount of water that is able to reach a potentially vulnerable entry point (for example, verandas or deep recessed porches).

Drained and vented cavities and trim cavities around doors and windows utilise pressure moderation as a tool against water entry. Because air can freely enter into a drained and vented cavity, the air pressure within the cavity should be the same or almost the same as that acting on the face of the cladding.

The air barrier created stops the flow of air (which can carry water) into the building.

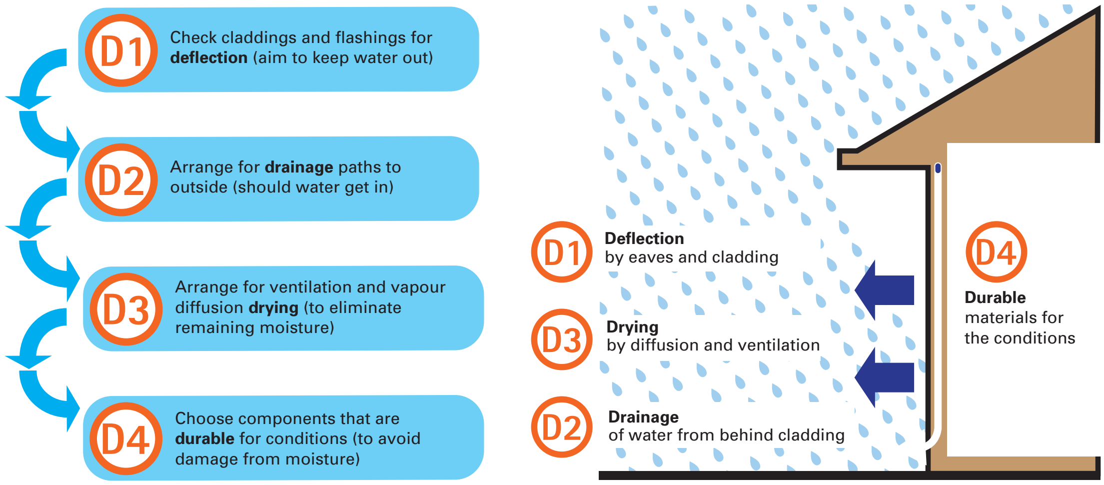


Figure A1.1 The 4Ds of weathertightness design.

A1.2 Drainage

Drainage involves providing paths for any water that does get past the cladding to allow rapid removal before it can damage wall components. This is the quickest and most effective method of getting rid of water that has penetrated joints and junctions in a wall cladding.

Drainage paths must be incorporated into the cladding construction to assist the removal of moisture. Drainage has traditionally been the function of building wraps and backflashings; however, by themselves, building wraps and backflashings offer limited protection in higher-risk situations. Drainage down the building wrap cannot be controlled and risks water penetrating into the framing.

Drainage is significantly improved by packing out the wall cladding with battens to create a drained cavity behind claddings. Water will drain in small cavities, but increasing the depth speeds drying by allowing ventilation as well. Speeding the drying process decreases the risk of fungal growth and decay.

A1.3 Drying

Drying is primarily by ventilation, but where ventilation rates are very low, diffusion of water vapour also contributes. However, while drying by ventilation may take days, drying by diffusion alone may take months (particularly if a wall is shaded) as the process is slow.

If there is no drying (or if drying is too slow), building materials such as timber eventually reach moisture contents that allow decay to start, even if they are treated to the minimum level of treatment now required for wall framing.

A1.4 Durability

Durability is about materials being appropriate for the anticipated in-use environment. It includes the concept of robustness so that materials do not fail immediately if exposed to conditions outside their specified range.

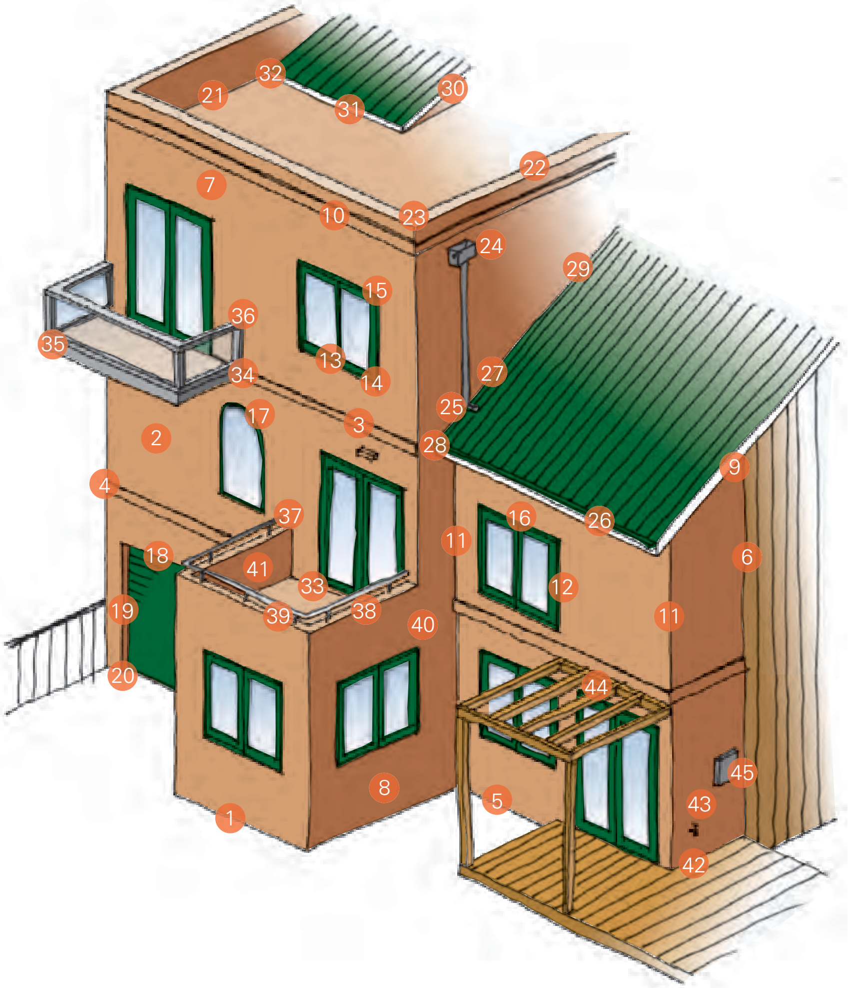
For example, using H1.2 treated timber in wall framing provides some protection against occasional wetting so that the timber can dry before damage occurs. With a more severe leak, it reduces the amount of damage that can occur before the fault is identified and rectified.

It is the designer's and builder's responsibility to ensure that materials are correctly specified, taking into account the environmental conditions and surrounding materials.

Maintenance is an important aspect of durability, and designers should ensure that maintenance requirements are realistic and made known to the owner.

APPENDIX 2 WEATHERTIGHTNESS RISK FEATURES

Figure A2.1 identifies the range of weathertightness risk features that may be encountered and their locations in a building. Risk features are locations or installation methods where water entry can occur. The sketch has been drawn from a 2009 study of the Department's determinations cases.



1. Base clearance
2. Vertical control joints/cracks
3. Horizontal control joints
4. Horizontal joints – corners
5. Cladding base
6. Intercladding junctions
7. Sheet joints
8. Material quality
9. Cladding top
10. Decorative bands
11. Corners
12. Window jambs
13. Window sills
14. Window sill/jamb junctions
15. Window head/jamb junctions
16. Window heads
17. Raked/curved window heads
18. Garage door heads
19. Garage door jambs
20. Garage door jamb bottom
21. Parapet/roof junctions
22. Parapet tops
23. Parapet top corners
24. Rainwater outlets
25. Downpipe spreaders
26. Roof edge gutter
27. Wall/roof junctions
28. Apron flashing bottom
29. Roof to wall clearances
30. Other roof flashings/skylights
31. Inter-roof claddings
32. Inter-roof/wall junctions
33. Deck/wall junctions
34. Deck perimeter/wall junctions
35. Deck perimeter
36. Open balustrade/wall junction
37. Clad balustrade/wall junction
38. Clad balustrade top
39. Handrail fixings
40. Deck drainage/overflows
41. Balustrade/deck junction
42. Timber deck/wall junction
43. Pipe penetrations
44. Pergola fixings
45. Meter boxes/grilles

Note: Additional and/or different areas of risk apply to other design forms or materials such as solid masonry or masonry veneers, solid timber walls, timber subfloors and so on.

Figure A2.1 Identified weathertightness risk features.

APPENDIX 3 EXAMPLES OF REMEDIATION REPAIRS

Figure A3.1 Before remediation.

Figure A3.2 After remediation.

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