Repointing with Lime Mortars

HTC 2:2020

June 2020

Heritage Technical Codes

HERITAGE COUNCIL VICTORIA

HERITAGE VICTORIA

VICTORIA State Government

Environment, Land, Water and Planning

Cover image

Repointing requires jointing tools, caulking or finger trowels, that fit within the joints so that the mortar can be tightly compacted against the bedding mortar behind. A range of tools of different widths are needed, as they must fit snugly into the joint to ensure good compaction. With the right materials, tools and technique no mortar need be smeared over the face of the brickwork.

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

© The State of Victoria, Heritage Council of Victoria 2020; and David Young 2020

All photographs and diagrams by David Young

ISBN 978-1-76105-176-0 (pdf/online/MS Word)

Disclaimer

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Accessibility

If you would like to receive this publication in an alternative format, please telephone the DELWP Customer Service Centre on 136186, email customer.service@delwp.vic.gov.au, or via the National Relay Service on 133 677 www.relayservice.com.au. This document is also available on the internet at www.delwp.vic.gov.au.

Repointing with Lime Mortars

HTC 2:2020

June 2020

Heritage Council of Victoria

Heritage Technical Codes: 2

Acknowledgements

The Heritage Council wishes to thank the Heritage Technical Code project steering committee and also the members of the Heritage Council's Heritage Fabric Specialist Committee, who reviewed and provided feedback on the development of this Code: Paul Coffey, Jeffrey Robinson, Natica Schmeder, Jenny Dickens, Adem Kose, Christophe Loustau, Greg Owen, Maggi Solly, Meredith Gould and Stuart McLennan.

Author

David Young OAM, BAppSc, M. ICOMOS. With a background in geology, David Young has specialised in the nature and performance of masonry materials in historic buildings. He has forty years' experience in the conservation of heritage buildings and sites around Australia. He is a past member of the South Australian Heritage Committee (now Council), the NSW Heritage Council's Technical Advisory Group and the Heritage Council of Victoria's Technical Advisory Committee. He is the author of detailed technical guides on mortars and repointing, and on salt attack and rising damp, which are published by State Heritage Councils.

Technical Codes produced by:
Heritage Council of Victoria
Department of Environment, Land, Water and Planning
GPO Box 527
Melbourne, 3001
Phone (03) 9194 0868
Website: www.heritagecouncil.vic.gov.au

Contents

Preface 1

1. Introduction 2

2. Scope and Application 2

2.1 Scope 2

2.2 Application 2

2.3 Key references 2

2.4 Definitions 3

3. Decision Requirements 5

4. Materials and Components 7

5. Execution 7

Appendix A Documentation 12

Appendix B Condition and risk assessment 14

Appendix C Compliance checklist 17

Appendix D Performance Solution Assessment 18

Preface

This Heritage Technical Code (the Code) is intended for application to places of heritage value, including those on the Victorian Heritage Register (VHR) and on the local Heritage Overlay (HO). The Code can also be applied to other buildings of similar age and materials. It has been developed to formalise successful traditional construction practices and techniques that are not documented in current commonly available construction manuals.

The Code has been designed to ensure that owners, government agencies, and heritage and building practitioners (including specifiers and contractors) use best practice in the repair, maintenance and conservation of heritage buildings and structures and other building types to which the Code applies.

The Code is suitable for building work addressed in the Building Code of Australia (BCA), which forms part of the National Construction Code (NCC). Appendix D to this Code is a Performance Solution assessment that provides evidence that construction in accordance with this Code will comply with the applicable NCC Performance Requirements.

The Code includes Normative and Informative clauses. To satisfy the requirement of this Code the Normative clauses must be followed. These clauses (and the Code as a whole) can be used as conditions for Heritage permit approvals issued by Heritage Victoria or local councils. Informative clauses, including diagrams and photographs, are advisory only, providing amplification and explanation of the Normative requirements.

This Code is only relevant to the construction system or process identified in section 2 Scope and application, and does not cover any other legislative or regulatory requirements that may apply to the work.

This Code has been compiled by David Young OAM, BAppSc, M. ICOMOS. Stuart McLennan (M. Eng, MAIBS) completed the Performance Solution Assessment in Appendix D.

It has been reviewed by the Heritage Council of Victoria's Heritage Fabric Specialist Committee, a body whose members have broad expertise in the conservation of buildings and structures, and has been endorsed by the Heritage Council of Victoria and Heritage Victoria

1. Introduction

This Code is about the practical aspects of using lime mortars to repoint mortars joints in historic masonry using traditional materials and techniques that are not commonly found in contemporary building practice.

2. Scope and Application

2.1 Scope

This Code is about the practical aspects of repointing mortars joints in historic masonry. It covers the investigations and decisions required before repointing and undertaking the actual repointing itself, including acceptable tools, raking and cutting out joints, pre-wetting, finishing, protection and curing.

This Code does not cover:

- the design and specification of lime mortars (this is covered in HTC 1:2020 *Lime mortars for the repair of masonry*)
- tuck pointing (which was also traditionally undertaken with lime mortars)
- grouting, plastering or rendering with lime mortars
- patch repair of masonry units with lime-based materials
- structural repairs—engineering advice should be sought wherever the structural adequacy of walls is a concern.

2.2 Application

This Code applies to repointing where lime mortars are specified. The mortars may be based on pure (non-hydraulic) limes, or natural hydraulic limes (NHLs) and may include pozzolanic additives.

The masonry buildings and structures to be repointed were commonly constructed with lime mortars prior to the middle of the twentieth century. There are also circumstances where older buildings constructed with cement, or cement and lime (composition) mortars, should be repointed with hydraulic lime mortars.

Repointing in accordance with this Code will provide a level of structural integrity to the masonry consistent with the original construction.

Seek advice from a specialist experienced in historic masonry who should apply the prescriptions of HTC 1:2020 to determine materials and mixes that are appropriate to the particular circumstances.

Following this Code involves the use of hazardous materials (limes and pozzolans) and appropriate safety measures must be adopted in accordance with the relevant Safety Data Sheets (SDS).

2.3 Key references

Australia ICOMOS. 2013. *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance, 2013*. Australia ICOMOS, Melbourne.

HTC 1:2020. *Lime mortars for the repair of masonry*. Heritage Technical Code, Heritage Council of Victoria.

Young, D. 2008. *Salt attack and rising damp: a guide to salt damp in historic and older buildings*. Heritage Council of NSW, South Australian Department for Environment and Heritage, Adelaide City Council, Heritage Victoria, Melbourne.

Young, D. 2020. *Mortars: materials, mixes and methods—a guide to repointing mortar joints in older buildings*. Heritage Councils of Victoria, New South Wales, Queensland, South Australia, Tasmania and Western Australia.

2.4 Definitions

A fuller list of definitions is provided in HTC 1:2020.

ashlar masonry	Stone masonry, dressed to fine tolerances and regular shapes, and laid with narrow (nominal 3 mm) mortar joints, sometimes in mason's putty.
batching	Process of proportioning the constituent materials for a mortar mix.
bedding mortar	Mortar used for laying masonry units (bricks, blocks, stones and terracotta).
binder	Materials, such as limes and cements, used in powder, paste or putty form, which harden to hold the aggregate particles together and bind to the masonry units.
carbonation	Hardening of calcium hydroxide (lime) by absorption of carbon dioxide from the air (in the presence of water) to form calcium carbonate.
cement	Binder that consists only of hydraulic materials (e.g. Portland cement). Cements harden by reacting with water (hydration).
compatible mortar	A compatible mortar will have physical properties such as strength, elasticity, porosity and permeability that are appropriate to the adjacent masonry. Mortar strength should be lower, while elasticity, porosity and permeability should be higher than those of the adjacent masonry units.
composition mortar	A mortar in which the binder is a composition of cement and lime; also called 'compo'.
curing	The process of ensuring (by maintaining appropriate moisture and temperature conditions) the chemical hardening of a binder, such as lime or cement, to form a solid material.
cutting out	Removing mortar from the face of a joint that is too hard to be raked out and must be cut out with sharp chisels and/or mechanical tools.
deep packing	Packing mortar into deeply eroded joints by tamping with purpose-made tools to ensure complete filling and compaction.
durability	The ability of materials to withstand the action of the weather over an extended period. Durability is not necessarily related to strength.
grout	A hydraulic binder (often mixed with ground limestone filler and sand) used in slurry form to fill voids in walls.
hardening	The chemical hardening of a binder, such as lime or cement, to form a solid material.
hydrated lime	Calcium hydroxide. The result of combining quicklime with water to produce either a wet hydrate (putty) or a dry hydrate (powder). The term is normally used for the dry powder form. It is also known as builders' lime.
hydration	The reaction that results from combination with water. It applies to quicklime, which reacts to become hydrated lime, and to hydraulic limes and cements, which harden by reacting with water to form hydrates.
hydraulic lime	A lime that hardens partly by reacting with water (hydration) and so can harden underwater. Hydraulic limes contain silicates and/or aluminates which harden by hydration, and calcium hydroxide which hardens by carbonation.
jointing	The process of laying masonry and finishing the mortar joints in one operation with a single bedding mortar; also see 'pointing'.
knocking up	Making a matured lime mortar workable by further mixing; also see 'reworking'.
lime	Confusingly, the term is used for quicklime, for slaked or hydrated lime and for hydraulic limes. It is also loosely used for other calcium compounds.
lime putty	A putty of calcium hydroxide made by slaking quicklime in excess water and allowing it to settle out until it is stiff enough to retain its shape without slumping.
masonry	Clay bricks, concrete bricks or blocks, stone and terracotta (the masonry units) laid in mortar to form walls or other structures.
mason's putty	A putty-like mortar made with lime putty, whiting, linseed oil and very fine sand (sometimes omitted). It is used in narrow-jointed ashlar masonry.

maturing	Ageing of lime putty, leading to finer particle sizes and greater workability. Also applies to lime mortars, which improve with maturing before use.
mortar	Any material that in wet paste form can be used to lay masonry or make plasters and renders, which then sets and hardens. Applies to clay-bound materials as well as those bound with limes or cement. Mortars generally consist of a binder and an aggregate.
natural hydraulic lime	Hydraulic lime made by calcining impure limestone that naturally contains silica or aluminosilicates in suitable proportions, without any additions. Three classes are identified by EN 459: NHL 2, NHL 3.5 and NHL 5.
non-hydraulic lime	Relatively pure limes, including lime putty and hydrated lime, that harden by reacting with carbon dioxide in the air (carbonation) rather than with water. Air lime, fat lime and high-calcium lime are alternative terms.
permeability	The property of a porous material that allows gas (such as water vapour) and fluids (such as water) to pass through it. Permeable materials ‘breathe’.
pointing	Original finishing of a mortar joint by raking out some of the bedding mortar and inserting a separate pointing mortar.
pointing mortar	Mortar used to finish joints by pointing. May differ from the bedding mortar in materials, mix proportions, colour and durability.
porosity	The void (or pore) space in a material, expressed as a percentage of the total volume.
porous aggregates	Crushed porous bricks or stones added to mortars in place of some of the sand to increase their porosity and permeability.
pozzolan	Fine-grained glassy materials containing reactive silica, and often alumina, that have no binding power of their own but combine with pure lime to make binders that are similar to hydraulic limes.
pre-wetting	Process of thoroughly wetting walls prior to repointing to control, or ‘kill’, their suction, so that mortars do not dry out prematurely.
pure lime	Lime made from relatively pure limestone, resulting in a non-hydraulic, high-calcium lime. Pure limes are also known as fat limes or air limes.
raking out	Removing mortar from the surface of a joint, using a raking tool or other tools, to enable pointing or repointing.
repointing	Replacing the outer part of a mortar joint in masonry, which may have been originally jointed or pointed.
rising damp	Upward migration of water in masonry due to capillary suction; often the medium for transporting soluble salts into walls.
sacrificial mortar	A mortar designed to fail in preference to (and so protect) the adjacent masonry. A sacrificial mortar will be significantly more porous and permeable, and of lower strength than the masonry units.
salt attack	Progressive decay of masonry materials due to cyclic crystallisation or hydration of soluble salts within the pores of the material.
salt damp	salt attack and rising damp
slurry	Thin mixture of solid material in water. Mortar mixes intended for grouting are made into slurries by the addition of plasticisers.
suction	The negative force exerted by the capillarity of porous materials. It draws water into walls and aids in adhesion of plaster and mortar.
tamping	Finishing a partly hardened mortar joint by direct striking of the surface with the ends of the bristles of a stiff-bristled brush. The end grain of pieces of wood can also be used.
tuck pointing	Finishing a mortar joint with a narrow ribbon of mortar over a different coloured background mortar that is coloured to match the bricks or stones.

3. Decision Requirements

Normative

3.1 Investigations and documentation required for the design of lime mortars used in repairs are identified in HTC 1:2020, clauses 3.2 to 3.7. The following clauses relate specifically to repointing.

Informative

Appendices A to C describe the documentation needed to substantiate the work.

3.2 Hazardous materials

Check for hazardous materials such as asbestos and lead white in old mortars and sealants.

This should involve close inspection by an experienced person and/or chemical analyses.

Hazardous materials such as asbestos and lead white require particular responses which are beyond the scope of the Code. Refer to statutory and other requirements for the safe management of these materials and involve a heritage professional in their removal to ensure the protection of the surrounding original fabric.

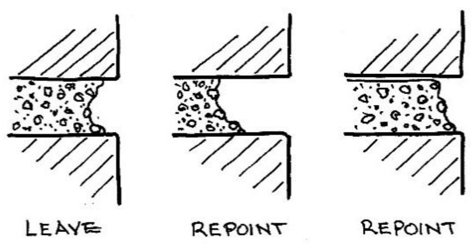
3.3 Joint profiles

Identify existing joint profiles around the building. Distinguish between repairs and earlier/original profiles.

3.4 Condition

Assess the condition of the existing mortars using the methodology in Appendix B. What is the depth of erosion or loss? Are the joints cracked allowing water entry? How does the condition vary around the building?

When to repoint:



A rule of thumb is that repointing should be undertaken where the depth of erosion is greater than the width of the joints. This would be 10 mm for normal brickwork. Cracked joints should generally be repointed.

3.5 Deeply eroded joints

Thoroughly investigate deeply eroded joints to determine whether joints in the body of the wall (particularly perpends) are filled with mortar.

Insufficient mortar in the body of solid walls may lead to water penetration through the full wall thickness. Deep packing and grouting may be needed to resolve the issue.

3.6 Salt damp

Any dampness in the masonry, such as rising damp and associated damage due to salt attack, must be understood and managed prior to repointing.

Repointing with deliberately sacrificial mortars may be part of managing a salt damp problem.

Normative | **Informative**

3.7 Match original/early mortars and joint profiles

Materials and finishes of original or early joints shall be matched as closely as practicable.

Tamped finishes may be required where the original finish is unknown and cannot be determined from the building, or where a weathered appearance is required to blend in with the remainder of the pointing.

See HTC 1:2020 and Appendix A.3 regarding the significance of mortars.

Tamped finishes may be required to maxi-mise the breathing capacity of a sacrificial mortar; see 5.9 Finishing joints.

3.8 When not to match

Previous repointing, undertaken with hard cement mortars (instead of a lime mortar) and/or with incorrect profiles, shall not be matched.

Some cement and composition mortars that require replacement may be best repointed with a mortar based on hydraulic lime, rather than one based on cement.

The reasons include the much higher strength and lower permeability of modern cement compared to early cements. Cases such as this require the input of a specialist experi-enced in historic masonry.

3.9 Extent of work

Keep repointing to the minimum necessary, particularly where the existing mortar joints contribute to the significance of the place or are significant in their own right.

3.10 Specification and schedule of works

Specifications and schedules of work shall address clauses 3.2 to 3.9 (above) and clauses 3.2 to 3.8 of HTC 1:2020.

In the specifications include clauses on:

- materials—binder(s), sands, admixtures, etc.
- mixes and how they are to be batched
- mixing and knocking up
- mortar samples and reference panels
- cleaning the masonry, using biocide if needed
- raking and cutting out joints
- pre-wetting—to control suction of the masonry
- repointing with tools that fit within the joints
- finishing with a known profile and/or a tamped finish
- protection—to prevent rapid drying
- curing—to ensure thorough hardening
- site practices—storage of materials
- compliance inspections and testing
- treatment of non-compliant work.

4. Materials and Components

Normative

4.1 See section 4 of HTC 1:2020 for details of materials and mixes.

Mortars that are stronger than those specified shall not be used.

Cement, or cement and lime composition mortars shall not be used for repointing joints that were originally jointed or pointed with lime mortars.

Informative

Table 2 in HTC 1:2020 sets out a range of acceptable mortar mixes. Table 3 in HTC 1:2020 provides guidance on selection of mixes for particular circumstances.

Pure and hydraulic limes will produce mortars that are more compatible with the historic masonry units than those made with cement. Compatibility is an essential aspect of successful repointing.

5. Execution

Normative

5.1 Mixing, maturing and knocking up

Refer to clauses 5.1 to 5.4 of HTC 1:2020.

5.2 Mortar samples

Make sample ‘biscuits’ of the full range of repointing mortars required for the particular job, allowing them to cure slowly, before breaking them to expose the true colour and texture on the broken face.

Informative: Sample biscuits are used to select trial mixes for reference panels.

5.3 Reference panels

Provide reference panels, a minimum of a square metre in area, one for each type of mortar or joint profile on the building. Once they are approved, retain the panels for the duration of the job.

5.4 Cleaning

Masonry surfaces shall be clean prior to repointing.

Informative: Depending on the nature of any soiling, the specified cleaning techniques may include a biocide for biological growths, or misting, washing or air-abrasive cleaning for dirt and dust.

Normative

5.5 Raking and cutting out

Joints are to be raked or cut out to 2.5 times the joint width, with a minimum depth of 20 mm. Joint surfaces are to be cleaned of mortar residue, and the back of the joint is to be left square.

Most lime mortars and some weaker cement and composition mortars can be raked out by hand or by using oscillating blade tools (e.g. mortar saws and multi-tools). Angle grinders and disc cutters are not acceptable when oscillating blade tools can be used successfully.

Hard cement mortars shall be cut out as follows. First cut a narrow slot along the centre of the joint with a small diameter diamond disc or cutting wheel. Then use a sharp tungsten-tipped mason's chisel to remove the mortar from the brick or stone.

Once the hard mortar has been removed from the outer part of the joint, use other tools to remove the softer mortar behind.

Clean joints and masonry faces of fine particles to prevent them becoming embedded in the surface. Flush them out and wash them down with water.

Informative

This photo illustrates damage to bricks from the use of angle grinders to cut out old mortar.

Using small diameter discs helps avoid overrun problems on perpend joints. Sections of stainless steel angle can be used as guards to prevent overruns.

By always working into the free space in the centre of the joint, hard mortars can often be removed without significant damage to the masonry units.

5.6 Pre-wetting

Pre-wetting is an essential step in the repointing process.

Thorough pre-wetting is needed to control the background suction of the masonry.

Begin spraying with a hose the day before repointing and spray several times on the day, the last time just before repointing. Surfaces shall be damp but not glistening.

For dense masonry materials (e.g. dense bricks, granites and bluestones) the last few sprays shall be via a nozzle that fits into the joints so that the porous mortar at the back of the joint can be thoroughly dampened without over-wetting the masonry units.

The high suction of very porous masonry materials (such as nineteenth and early twentieth century bricks, many sandstones and limestones and lime mortars) will draw water from the new mortar making it difficult to work.

Building up a 'bank' of water in the wall also helps prevent premature drying of the new mortar which would lead to poor hardening and low durability.

Normative

Informative

5.7 Repointing—acceptable tools

Acceptable tools include caulking or finger trowels of different widths that fit within the joints. For brickwork the trowels shall be cut down to no more than 70 mm in length to suit perpend joints.

Mortar guns and pumping systems are acceptable for placing mortar into joints, but only if the mortar does not run down over the face of the wall and the mortar is subsequently compacted with tools that fit within the joints.

Triangular pointing trowels and any other tool that does not fit within the joints are not acceptable.

Backing rods are not acceptable as they prevent moisture transport through the mortar joint.

The use of masking tape to protect the face of the masonry units is acceptable, particularly for narrow joints in ashlar masonry.

Caulking or finger trowels in a range of widths that fit snugly into the joints are a critical part of repointing. Here a wedge of stiff mortar is being inserted into a narrow perpend joint with a 4 mm wide trowel.

Use low residue masking tape to avoid marking the masonry.

5.8 Repointing procedure

Use stiff dryish mixes to fill the joints and tightly compact the mortar with considerable force. Build out in layers forcing the mortar back into the last placed section. Do not overwork the joint by sideways striking of the mortar.

Fill deeply raked-out joints in 25–30 mm stages, leaving at least 20 mm for the last stage. Allow three days between stages and keep new work damp with fine water sprays.

Slightly overfill the joints to allow for some compaction and shrinkage. Do not attempt to clean up the joint at this stage.

Filling joints by smearing wet mortars into them and over the face of the masonry units, followed by a clean-up using acid and pressure washing, is unacceptable.

By using stiff dryish mixes and tools that fit within the joints there need be no spills or smears of mortar on the face of the masonry.

Right handers should work from right to left, and left handers from left to right.

Any grouting of voids in the centre or core of a wall should be completed before the final stage of repointing.

Ignore small ‘crumbs’ of mortar that may be left on the face. Because of the stiff dry mix they will not adhere strongly to the masonry and can be flicked off with a trowel during finishing.

Correct use of tools that fit within the joints and stiff mixes means that no mortar need be left on the face of the masonry.

Normative

Informative

5.9 Finishing joints

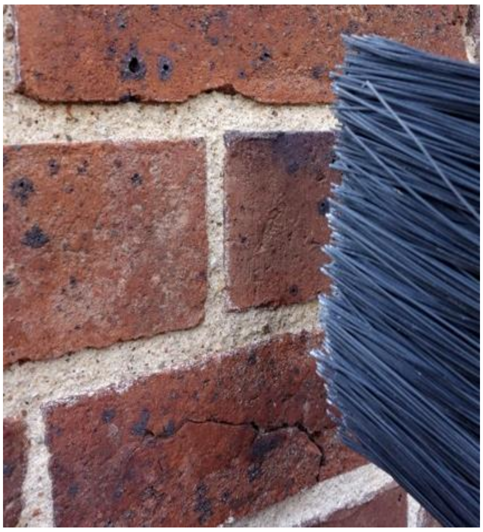
Allow the mortar to stiffen a little before applying the specified profile or joint finish. A finish applied by trowel will need to be undertaken sooner than a tamped finish.

The timing will depend on:

- how hydraulic the mix is
- the climate
- the porosity and suction of the masonry
- the amount of pre-wetting
- the specified joint finish.

Triangular pointing trowels and plasterers' small tools are acceptable for this stage of the work.

Tamping is a direct striking of the surface with a stiff-bristled brush, such as a churn brush.



Tamping the surface with a stiff-bristled brush compacts the mortar, exposes the colour and texture of the sand grains and produces a weathered appearance. Tamping is undertaken when the joint surface is still leather hard—when a fingernail can just be pushed into the mortar.

5.10 Protection

New work shall be protected from frost, rain, sun and, particularly, wind for a minimum of four weeks after laying masonry or repointing joints. The protection system shall be capable of maintaining the humidity against the walls above 60% Relative Humidity (RH).

Unacceptable work conditions are temperatures below 5°C and above 30°C unless misting systems are in place to maintain humidity.

Stage work around the building to avoid hot sun.

Protection shall be in place from pre-wetting until the end of the specified curing period.

Rapid drying of any mortar will lead to early failure. This is particularly the case for lime mortars as they harden slowly and require the continuing presence of water to harden correctly. This is why protection and curing are so important.

Depending on the local climate, protection may be in the form of a tightly enclosed ('shrink-wrapped') scaffold, fitted with intermittent misting systems to control humidity.

Smaller-scale ground-level works can be protected by draping dampened removalists blankets or carpet in front of the work. Hessian has been commonly used but this dries too quickly in warm or windy weather and is not suitable unless it is covered with plastic sheeting to prevent rapid evaporation

5.11 Curing

Establish a curing regime of alternate weeks of wetting and 'drying'. This shall begin as soon as repointing is complete, and be maintained over the full curing period, including weekends:

- during the first week of wetting the Relative Humidity (RH) is to be maintained above 90% using fine water sprays to keep the masonry quite damp

The only exception to the normative curing regime is where the climatic conditions (cool, but not cold temperatures, and relative humidities above 60%) are favourable. Such conditions should be documented and not just asserted. Smartphone weather apps can be used to monitor local humidities and so determine whether additional spraying is required.

Normative

- during the second week of ‘drying’ the RH is to be maintained above 60% with light spraying around midday and in the mid–late afternoon in warm to hot weather
- wetting during the third week is to consist of heavier spraying three to four times a day with the RH kept above 60%;
- the fourth week is a repeat of the second.

This curing regime applies to all lime mortars, irrespective of binder type and mix proportions.

For exposed locations the period of protection and curing shall be extended by a further two weeks of wetting and drying. At the end of the works the masonry shall be thoroughly wet down.

Informative

Even in ideal conditions wetting will still be required in the first and third weeks.

Exposed locations include towers and spires, chimneys and coastal environments where higher wind speeds are common.

Appendix A Documentation

A.1 Building survey

There should at least be a basic understanding of the history of the building. Was it built in stages and when? The detail required will depend on the scale, the extent of the proposed repairs and changes to the building.

Undertake a close visual examination of the different elements of the building or structure with the aim of determining:

- Is there a single bedding/jointing mortar?
- Or were the joints pointed with a separate mortar that differs in materials and appearance?
- Was the building tuck pointed?
- Do the joint finishes change around the building, with more elaborate finishes (e.g. tuck pointed, or ruled and pencilled) at the front, and plainer finishes (e.g. flush jointed) on side and rear walls?
- Has the building been repointed in part or whole (look for mortars of different colours and textures and joints of different widths and profiles)?
- Is there any evidence of the original pointing, which may be hidden behind downpipes or later fixtures (such as signs or meter boards) or left in difficult to reach parts, such as chimneys?
- Does the repointing match the original in materials, appearance and joint profile?

A.2 Mortar analysis

The nature and extent of mortar analyses to be conducted will depend on the significance, complexity and circumstances of the particular project. Laboratory analyses may be needed to clarify the significance of an uncommon mortar, or to unravel a complex series of mortars and phases of repair. Mortar analyses may also be required to understand the condition and conservation needs of a building or structure.

A.2.1 Visual examination

For straightforward cases, close examination with a 10x hand lens may provide all the information required to understand the existing mortars and to design repair mixes:

- Document the shape, size and colour of the sand and any other aggregates such as shells or charcoal.
- Document the overall colour of the mortar. A grey colour may indicate the presence of cement (at least grey cement) but may also be due to the colour of the finer particles in the sand, or to the use of pigments.
- Does the mortar contain prominent white lumps of lime, which indicate its origin as a sand-slaked quicklime mortar? Or is the binder not particularly obvious (compared to the sand), which may suggest hydrated lime, cement, or composition binders?
- How does the pointing mortar (if present) differ from the bedding mortar behind?
- Document the nature of any repair mortars.

Simple scratch tests (with a screwdriver or similar tool) have been used to distinguish between a lime mortar and those containing cement. However, this method is not recommended — a well-made lime mortar may be more resistant to scratching than a poorly made or deteriorated cement or composition mortar.

A.2.2 Basic chemical analysis

Pure lime mortars can be readily disaggregated in dilute (10%) hydrochloric acid and, provided there is no carbonate mineral in the sand, the proportions of binder to sand can be determined. Acid tests should be done on a sample of unweathered mortar taken from an unobtrusive location. Dry and weigh the sample before starting the test.

The aggregate left behind should be washed, dried and weighed to determine the ratio of binder to aggregate. If the sample is large enough, the size grading of the sand can be established by screening according to AS 1141 (see clause 4.3). Determine the void ratio by measuring the amount of water required to fill the voids in a known volume of dry sand.

Any lumps of sand and binder remaining after the initial acid digestion indicate the presence of hydraulic components—hydraulic lime, pozzolan or cement—which will require more detailed analysis to distinguish between them.

Salt analyses will be needed to diagnose and manage a salt damp problem. These can be simple TDS (total dissolved solids) measurements using a conductivity meter. These tests give the total amount of soluble salt but do not identify the type(s) of salt present. Paper indicator strips can be used to identify common salts (e.g. chlorides, sulfates or nitrates).

Detailed laboratory analyses of the salts may assist in determining the nature and origin of the salt.

A.2.3 Specialised laboratory analysis

Chemical analysis of mortars should be undertaken according to AS 2701. Complex mortars (particularly those with hydraulic components) may warrant detailed examination using a combination of polarised light microscopy (petrography) and wet chemical analyses as specified in ASTM C1324-15.

Techniques are available for documenting the physical properties of existing and new mortars (e.g. porosity, permeability and bond strength). These may be required in particular circumstances such as where structural interventions are needed, or where the condition of the masonry warrants a specialised approach.

A.3 Significance

Do the existing mortars contribute to the significance of the building or structure? Original mortars and joint profiles (even if weathered with some loss of detail) contribute to the building's significance if that significance is embodied in the fabric and form of the place.

The significance of a building may relate principally or, in part, to a later phase in its history when additions saw changes to the mortars and joint profiles. The evidence of these changes should be acknowledged and retained, not removed in favour of the original.

Where changes to a building are themselves of heritage significance it is important that repair mortars should match the respective originals in materials and joint profiles so that the story of the changes remains evident in the building.

Poor quality, poorly executed repairs (e.g. mortar smeared over the face of bricks) using inappropriate materials (such as cement or non-matching sands) have a negative impact on significance. Their replacement with compatible mortars may reveal aspects of significance (by reconstructing original joint profiles), but the sympathetic repairs themselves have a neutral impact on significance.

Mortars that are significant in their own right (as distinct from forming part of a masonry assemblage) are likely to be rare and involve unusual materials or finishes. Assessment of the significance of such mortars should include comparison with other examples in the locality, State, etc.

Appendix B Condition and risk assessment

B.1 Condition

This appendix provides a basis for assessing and ranking the condition of the mortars in a building. Because of the intimate relationship between mortar and masonry units, the condition of both must be assessed to inform decisions about repair needs. Table 4 sets out a scheme for ranking condition and assigning a corresponding risk, based on five elements of masonry walls. Note that this is a condition assessment of the materials, not an engineering assessment of the structural soundness of the walls, which may also be warranted.

Condition and risk assessment

Element	Condition	Rank / Risk
Mortar joints	Imperceptible to slight loss of surfaces	
Masonry units	Sound, no significant sign of decay	
Repairs	Compatible materials and profiles	Good / Little risk
Wall cores	Sound, no apparent losses	
Wall cavities	Sound, no losses from internal surfaces	
Mortar joints	Joints eroding in places, but generally less than 10 mm	
Masonry units	Slight decay, less than 5 mm of surface loss	
Repairs	Compatible materials, but poor aesthetics	Fair / Low risk
Wall cores	Joints not fully filled, but no losses or water penetration	
Wall cavities	Slight loss of mortar (<10 mm) from internal surfaces	
Mortar joints	Joints deeply eroded, generally more than 10 mm	
Masonry units	Moderate decay, generally more than 5 mm of surface loss	
Repairs	Incompatible materials but in a relatively benign situation	Poor / Vulnerable
Wall cores	Some voids and losses, reduced bonding, water penetration through wall	
Wall cavities	Moderate loss of mortar (>10 mm) from internal surfaces	
Mortar joints	Joints very deeply eroded, more than 30 mm	
Masonry units	Deeply decayed or lost entirely	
Repairs	Incompatible materials causing active decay	Very poor / At risk
Wall cores	Extensive voids and losses, poor bonding, water penetration through wall	
Wall cavities	Severe loss of mortar (>30 mm) from internal surfaces	

Note: condition rank and risk should be assigned based on the worst case of any one element.

B.2 Agents of decay

The following list is provided to aid identification of the agents of decay, so that correct remedial measures can be designed:

- water—as rain strike, and as drawn into walls by capillary suction (rising damp)
- salt damp—salt attack, particularly associated with rising and falling damp, but also associated with salts originally in the masonry materials
- freeze/thaw cycling—of water, but only in cold climates

- wind—prevailing winds, keeping walls wetter on the weather side (encouraging biological growths, such as lichens); and, particularly in coastal areas, adding salts to walls
- floods—saturating the base of walls, delivering salts from backed up sewers, and mobilising inherent salts
- structural movement (earthquake/settlement)—causing cracking and allowing water entry
- inherent vice—including insufficient mortar in the body of solid walls, insufficient binder in the mortar mix, poor quality sands, brick growth and corrosion of steel cramps and bond straps
- previous treatments—cleaning and paint removal by high pressure water or sand blasting; repairs using impermeable and excessively strong cement-based mortars; repairs using compatible lime mortars, but with inadequate desalination, or insufficient curing, leading to premature failures.

B.3 Extent of damage

Planning and prioritising repairs will be assisted by mapping the extent of damage around a building or structure and assigning a condition rank to each area or element as outlined in Table 4. The extent of damage can be divided into:

Small areas

- around overflowing downpipes or other water leaks
- structural cracks—single cracks and small areas of intensive cracking
- localised patches of mortar loss as a result of aggressive graffiti removal.

Large areas

- parapet and gable copings, and the ‘protected’ areas immediately below copings and cornices
- around the base of the building due to rising damp and associated salt attack
- on the weather side, due to prolonged wetting and coastal winds
- inherent vice, as note above
- previous treatments such as sand blasting, inappropriate repointing.

B.4 Assessing risks

When considering risks, those arising directly from condition (B.1) should be modified to take account of external risks (such as earthquakes, exposure) and risks associated with the use (or lack of use) of the place in question. Hence a building (or part of a building) classed as vulnerable might be considered at risk in an area of seismicity, or if it is abandoned or neglected. The risk assessment should inform decisions about priorities and the selection of mortar materials and mixes to be used in the repair or stabilisation of the building.

Appendix C Compliance checklist

C.1 Introduction

This appendix sets out recommendations for ensuring compliance with this Code. The specification (clause 3.10) should include provision for inspection of works, site investigations, and sampling and chemical analysis to test mortar mixes. The specification should also prescribe how non-compliant work is to be dealt with.

C.2 Site inspections and investigations

The appropriate frequency of site inspections will depend on the scale and timeframe of the project. Inspections should be sufficiently frequent to enable realistic and timely responses from the contractor undertaking the work.

Include checking and sampling of the following during site inspections:

- the raw materials (HTC 1:2020 clauses 4.1–4.7 and 4.9–4.11 and Table 1)
- the mortar types and mixes (HTC 1:2020 clause 4.8 and Tables 2 and 3)
- the mixing process (HTC 1:2020 clauses 5.1–5.4).

Assess these work practices for their compliance:

- pre-wetting (clause 5.6)
- protection (clause 5.10)
- curing (clause 5.11).

Check the following aspects of repointing work (clauses 5.2–5.9):

- cleaning the masonry, if needed
- raking and cutting out process and tools used
- depth and cleanliness of the raked-out joints
- method of packing (repointing) the joints
- finished appearance of joints, including profiles, colour and texture
- do the finished joints match the reference panels agreed at the start of works?

C.3 Sampling and chemical analysis

Sampling of the new mortar(s) may include fresh material and hardened mortar taken from different parts of the site. Chemical analysis of mortar samples may be required to confirm the nature and proportion of the constituent materials. The contract and specification should assign responsibility for conducting testing.

C.4 Non-compliant work

How non-compliant work will be managed should be clear to all parties from the beginning of the project. Responses to non-compliant work may include defecting of all materials and mixes that are found to be not as specified. In the case of repointing, work that is to be defected, for example because of insufficient raking out, may warrant removal and replacement of all work undertaken since the previous inspection.

Superintendents must allow for tolerances in non-complying materials and mixes. For example, to ensure workability the specification should allow for final adjustment of the mix proportions to be made by the mason on site, within set limits. Chemical analyses of mixes will need to be interpreted with this in mind.

Appendix D Performance Solution Assessment

1.0 Introduction

This appendix has been prepared to provide evidence that the repair of existing buildings using lime mortar in accordance with the Heritage Technical Code HTC 2: 2020 *Repointing with lime mortars* will comply with the Performance Requirements of the Building Code of Australia (BCA).

The BCA which forms part of the National Construction Code (NCC), is adopted by the *Building Act 1993* (Act) in Victoria and contains the technical requirements for the construction of buildings. As part of the building permit process, the Relevant Building Surveyor is required to assess the proposed work for compliance with the BCA.

In most instances, the repair of buildings using the Heritage Technical Code will be deemed as maintenance work under the Act and a building permit is not required.

However, in situations where the use of lime mortar is proposed as part of the work which requires a building permit, the permit applicant can submit this appendix and Heritage Technical Code as evidence that the use of lime mortar as defined in the Heritage Technical Code is a Performance Solution which will satisfy the relevant Performance Requirements of the BCA.

1.1 Scope of Performance Solution Assessment

The Performance Solution assessment applies to the following codes:

a. Building Code of Australia, Volume One (Class 2 to 9 Buildings)

b. Building Code of Australia, Volume Two (Class 1 and 10 Buildings)

This report proceeds on the assumption that all other aspects of the building design not addressed in the Performance Solution complies with the BCA. If the building design fails to comply with the BCA, then the proposed Performance Solution may be compromised.

The assessment is limited to the matters described in the Performance Solution description. Comment is not provided on any other matter.

1.2 BCA Performance Solution Process

The *Building Act 1993* nominates the BCA as the minimum construction standard for buildings in Victoria. The BCA is a performance-based building code that has a series of Performance Requirements which must be met.

Generally there are three options for complying with the BCA Performance Requirements. The first method is the use of a Deemed-to-Satisfy Provision, the second is a Performance Solution and the third is a combination of both approaches.

The Deemed-to-Satisfy Solutions are optional methods of compliance and often fail to reflect successful construction practices commonly used by the building industry. A Performance Solution is a method of construction that is not described in the Deemed-to-Satisfy Solutions. However, it complies with the appropriate Performance Requirement.

1.3 Regulatory Application

The Relevant Building Surveyor is required to consider whether proposed building work will comply with the requirements of the Building Act and Regulations, which includes the BCA. As part of that process, there should be documentary evidence to validate that a Performance Solution complies with the relevant Performance Requirement.

This Appendix to the Heritage Technical Code, which has been prepared in accordance with BCA Part A2, provides evidence of compliance and as such is suitable for consideration and approval by the Relevant Building Surveyor in accordance with Part 4 of the *Building Regulations 2018*.

2.0 Performance Solution Proposal

2.1 Performance Solution description

The proposed Performance Solution is to allow the repointing of existing masonry using a lime mortar complying with the Heritage Technical Code HTC 2: 2020.

2.2 Reasons for the Performance Solution

The use of lime mortars is not recognised in the BCA Deemed-to-Satisfy Solutions. Therefore the system is considered to be a Performance Solution.

2.3 Performance Solution overview

Nature of proposed building work	Details to be included by Designer
Building Classification	Details to be included by Designer
Prescribed class of building work	Design of building work
Building Code of Australia, Volume One Class 2 to 9 Buildings	
Relevant Performance Requirements	BP1.1 – Structural reliability FP1.4 – Weatherproofing FP1.5 – Rising Damp
BCA Deemed-to-Satisfy Solutions	There are no Deemed-to-Satisfy Solutions for the repointing of masonry using lime mortars.
Building Code of Australia, Volume Two Class 1 and 10 Buildings (Housing Provisions)	
Relevant Performance Requirements	P2.1.1 – Structural stability and resistance to actions P2.2.2 – Weatherproofing P2.2.3 – Rising Damp
BCA Deemed-to-Satisfy Solutions	There are no Deemed-to-Satisfy Solutions for the repointing of masonry using lime mortars.
BCA Assessment method	Clause A2.2(2)(c) – Expert judgement
Details of expert judgement	Expert judgement has been used to assess the proposed Performance Solution for compliance with the BCA. The expertise of the assessor has been used to analyse the BCA Deemed-to-Satisfy Solutions and the underlying intent of the BCA to determine whether the proposed Performance Solution satisfies the BCA Performance Requirements.
Details of any tests or calculations	There have been no tests or calculations undertaken in this report.

2.4 Reference Information used in this Assessment

The following documentation has been used in the preparation of this report:

a. Building Code of Australia, Volume One, Class 2 to 9 Buildings 2019 (BCA Volume One).

b. Building Code of Australia, Volume Two, Class 1 and 10 Buildings (Housing Provisions) 2019 (BCA Volume Two).

c. AS 3700:2018. *Masonry structures*.

d. AS 4773.2:2015. *Masonry in small buildings, Part 2: Construction*.

e. *HTC 1:2020. Lime mortars for the repair of masonry. Heritage Technical Code, Heritage Council of Victoria.*

f. Young, D. 2008. *Salt attack and rising damp: a guide to salt damp in historic and older buildings*. Heritage Council of NSW, South Australian Department for Environment and Heritage, Adelaide City Council, Heritage Victoria, Melbourne.

g. Young, D. 2020. *Mortars: materials, mixes and methods — a guide to repointing mortar joints in older buildings*. Heritage Councils of Victoria, New South Wales, Queensland, South Australia, Tasmania, and Western Australia.

3.0 Performance Solution Assessment

3.1 BCA comparative analysis

3.1.1 Introduction

The BCA under clause A2 requires a comparative assessment to be undertaken between the proposed Performance Solution and any associated Deemed-to-Satisfy Solutions and Performance Requirements. This is achieved by analysing:

a. The Deemed-to-Satisfy Solutions (clause A2.4(3)(a));

b. Direct Performance Requirements (clause A2.4(3)(b)); and

c. Indirect Performance Requirements (clause A2.4(3)(c)).

The intent of this process is to identify the Deemed-to-Satisfy Solutions/s (in some instances there may be no Deemed-to-Satisfy Solutions) and the relevant Performance Requirements that relate to the Performance Solution.

The BCA assessment process also requires consideration to be given to the impact on any associated Performance Requirements that may occur if the Performance Solution is adopted.

3.1.2 Deemed-to-Satisfy Solutions

There are no BCA Deemed-to-Satisfy Solutions for the repointing of an existing masonry wall using lime mortars.

3.1.3 Direct Performance Requirements

The following is a summary of the relevant Performance Requirements that relate to the proposed Performance Solution:

A. Structural reliability, stability and resistance

The relevant BCA structural Performance Requirements Performances that apply to the proposed Performance Solution are in BP1.1 (BCA Volume One) and P2.1.1 (BCA Volume Two).

The Performance Requirement requires the building to achieve an acceptable level of structural performance:

1. So that the structure will remain stable and not collapse; and
2. Minimise local damage and loss of amenity through excessive deformation or degradation.

B. Weatherproofing and Rising damp:

Interpretation – Weatherproofing:

The relevant BCA weatherproofing Performance Requirements Performances that apply to the proposed Performance Solution are in clause FP1.4 (BCA Volume One) and P2.2.2 (BCA Volume Two).

The Performance Requirements are designed to ensure that the external walls are designed to restrict water from entering the building. The reasons for this are to:

1. Prevent moisture from creating unhealthy conditions for the building occupants.
2. Prevent dampness from causing deterioration of the building elements.

Interpretation – Rising damp:

The relevant BCA rising damp Performance Requirements Performances that apply to the proposed Performance Solution are in FP1.5 (BCA Volume One) and P2.2.3 (BCA Volume Two).

The Performance Requirement is designed to restrict ground moisture from reaching the upper levels of masonry. The reasons for this are the same as those for weatherproofing.

It is important to note that the walls are simply required to be weatherproof and not waterproof, which assumes that some dampness will occur and is acceptable provided it does not cause structural failure and unhealthy conditions for the occupants.

3.1.4 Related Performance Requirements

BCA clauses A2.2(3) and A2.4(3) requires the Performance Requirements in other Sections or Parts of the BCA that are relevant to the proposed Performance Solution to be analysed to determine if there will be a negative impact if the Performance Solution is approved.

The assessment has identified that there are no Performance Requirements that will be affected in a significant manner if the proposed Performance Solution is approved. This is due to the proposed Performance Solution achieving an equivalent level of performance to that achieved by utilising the Deemed-to-Satisfy Solutions. Accordingly, the impact of the Performance Solution on other BCA Performance Requirements will be negligible.

3.2 Performance Solution Assessment

3.2.1 Preliminary

As required by BCA clause A2.2(2) the following is an assessment of the Performance Solution and provides evidence as to why the proposal should be accepted as meeting the Performance Requirement.

3.2.2 Assessment Method

The Performance Solution is assessed using Expert Judgement, which is an accepted method under BCA, clause A2.2(2)(c).

Consideration has also been given to comparing the proposed Performance Solution against the level of function required under the BCA Deemed-to-Satisfy Solutions. This is a recognised approach under clause A2.2(1)(b) which explains that if the proposed design is at least equivalent to the Deemed-to-Satisfy Solutions then the design is deemed to meet the Performance Requirement.

3.2.3 Supporting evidence

The following evidence has been used in considering this Assessment:

a. Historical evidence as defined in previous government sanctioned construction standards. These standards have worked successfully in Victoria as reflected in the performance of buildings constructed using these standards.

b. Evidence of the long-term performance of older buildings.

3.2.4 Reasons to accept the Performance Solution

3.2.4.1 Historical use of proposed system

The proposed Performance Solution is based on “old” building systems previously enshrined in legislation and traditional practices which are still being used in Victoria and nationally in traditional and cultural heritage building practice.

Justification for the acceptance of these “old” systems is based on a satisfactory level of performance, which is clearly exhibited in the functionality of existing building stock. The number of existing buildings that have been constructed using traditional lime mortar and still maintaining the safety, weather-tightness, amenity and health for the building occupants supports the use of lime mortars to repoint masonry during the repair of those buildings.

3.2.4.2 Status of Heritage Technical Code

Many current construction standards are not appropriate for heritage buildings. The application of some of these construction practices may cause unacceptable and irreversible damage to the existing building fabric.

In order to address this issue the Heritage Council of Victoria have implemented a process to codify and formalise traditional practices so that they can be adopted as part of the BCA and associated building legislation approval process. They are also suitable for other legislative purposes and building contract documentation.

The Heritage Technical Codes have been written by experts in the particular discipline and if followed will achieve acceptable construction outcomes and comply with the BCA.

3.2.4.3 Expert development and peer review

The Heritage Technical Code has been developed by David Young OAM, BAppSc, M. ICOMOS. With a background in geology, David Young has specialised in the nature and performance of masonry materials in historic buildings. He has forty years' experience in the conservation of heritage buildings and sites around Australia. He is a past member of the South Australian Heritage Committee (now Council), the NSW Heritage Council's Technical Advisory Group and the Heritage Council of Victoria's Technical Advisory Committee. He is the author of detailed technical guides on mortars and repointing, and on salt attack and rising damp, which are published by State Heritage Councils.

The Code has been endorsed by the Heritage Council of Victoria following review by its Heritage Fabric Specialist Committee and Heritage Victoria and it has been determined that the code is suitable for publication.

The expertise and assessment are considered to be consistent with BCA clauses A5.2(1)(e) and A5.2(1)(f) Evidence of suitability.

The development and peer review process provide confirmation that the Heritage Technical Code will satisfy the relevant requirements of the Building Code of Australia.

3.3 Conclusion

This Assessment conducted in accordance with Part A2 of the BCA concludes that the use of lime mortar to repoint an existing building in accordance with Heritage Technical Code HTC 2:2020 is acceptable for the repair of buildings and meets BCA Volume One and Two Performance Requirements for structural stability weatherproofing and rising damp as:

a. The Heritage Technical Code HTC 2:2020 has been developed by experts in masonry construction and is considered to provide a level of performance equivalent to the BCA Deemed-to-Satisfy Solutions.

b. Historically, buildings using lime mortar have performed successfully. These buildings continue to perform with acceptable levels of safety, serviceability and amenity which provide conclusive proof of the suitability of the proposed Performance Solution. The repointing of the existing walls using a lime mortar will retain the integrity of the existing structure.

3.4 Report Conditions

The following conditions apply to this report and must be adopted. A failure to adopt these conditions will mean that the report is no longer valid.

a. The report (including any report conditions) is to be approved by the relevant building surveyor as part of the building permit documentation.

b. The building is to be constructed in accordance with the Performance Solution, report conditions and the design documentation as detailed in this report.

c. The architectural drawings and specifications are to be amended as necessary to align with the Performance Solution and the design documented in this report.

d. The lime mortar system is limited to the repair of existing buildings.

Note: Lime mortars, particularly those with hydraulic properties, may be appropriate for new building work. However, the mortar design and structural parameters would need to be specified by competent structural engineers with appropriate experience in lime mortar use. Assessment using Australian Standard AS 3700 and AS 4773 Parts 1 and 2 are not appropriate as these standards do not recognise the use of lime mortars.

a. The level of weatherproofing achieved by the remedial work using lime mortars will be consistent with the existing use of the wall.

Note: If the existing wall use is to be changed as part of the building work (i.e. from a non-habitable room to a habitable room), the level of weatherproofing will need to be investigated to determine the need for any additional measures such as cavity wall construction or applied wall treatments.

Note: The failure to apply these conditions will make the assessment void and the report can no longer be relied upon to confirm compliance with the BCA.

delwp.vic.gov.au