

# Heritage Building Conservation Technical Advice Sheet 5

## Dealing with dampness in old walls



Damage from rising damp on the internal face of wall (above) and external face (below).



### Rising damp · falling damp · salt attack

This technical advice sheet is about understanding how dampness and associated salts affect old walls and how best to manage them. It focuses on rising damp at the base of walls, but also notes that dampness falling from the tops of walls can cause decay.

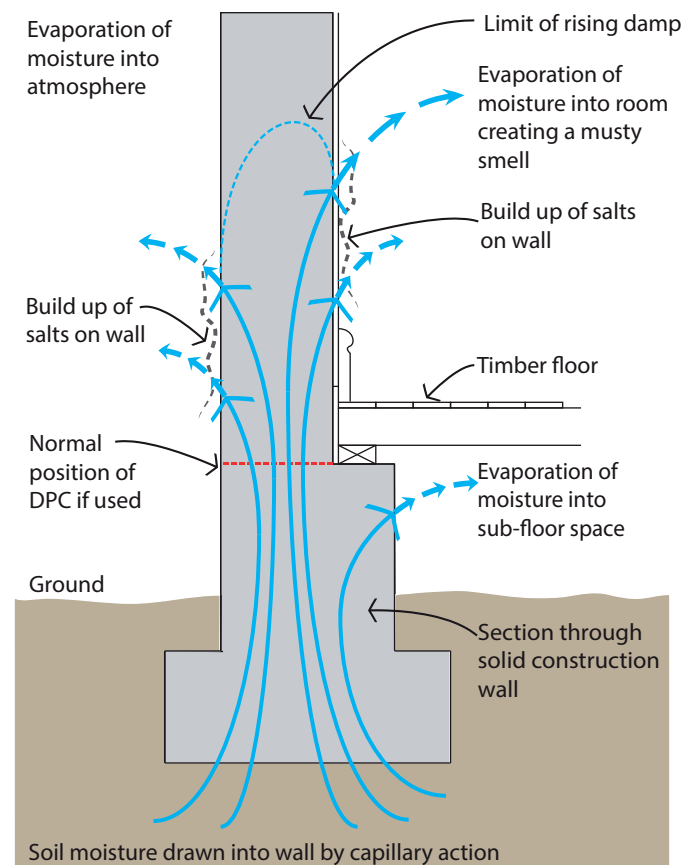
This sheet follows on from 3 *Looking after limestone walls* which should be read first. One of the common repairs needed when dealing with dampness is replacing (repointing) the mortar joints between bricks and stones, so sheets 4 *Limestone walls need lime mortars*, and 6 *Repointing lime mortar joints* should also be consulted.

### Walls breathe

Old walls are porous — in wet weather they absorb water like a sponge, and give it up in dry periods. The exchange of air and water vapour between porous masonry and the atmosphere is called 'breathing', and it's essential that old walls should continue to breathe. Attempts to seal them, 'to keep the damp out', will inevitably trap moisture inside the wall and cause more serious decay.

### Rising damp

Dampness at the base of old walls is commonly due to the finer pores in the masonry drawing soil moisture up into the wall by capillary action, or suction. The dampness rises until it evaporates from the wall surface, often leaving a 'high-tide line' at the top of the damp zone. Internally, dampness can cause plaster to crumble, damage paintwork and wallpaper, and produce musty smells and moulds. If excessive, the moulds can be unhealthy, particularly for asthmatics.



Rising damp is due to the capillary suction of porous masonry.

## Rising damp (cont'd)

Today, masonry walls are constructed with a moisture barrier known as a damp-proof course (DPC), which is built in at the base of the wall, on top of the concrete slab footing. DPCs were not generally used until late in the nineteenth century, and many early ones, such as roofing slates laid in a mortar course, or a mixture tar and sand, have not proven to be fully effective. Consequently, many older buildings, as well as some much younger ones, are affected by rising damp.

Rising damp problems are often made worse by rain splashing off hard paving, by watering gardens that are too close, and by failure of roof drainage systems to carry stormwater well away from the walls.

## Salt attack

Rising damp is particularly damaging when it is accompanied by soluble salts, such as common table salt (sodium chloride). The salt may be derived from the soils beneath the building, from sea spray if close to the coast, and other sources including garden fertilisers and inappropriate cleaning compounds.

These salts cause the commonly observed fretting and crumbling of bricks, stones, mortars, plasters and renders. As water evaporates from a wall surface it leaves the salts behind and they grow as tiny crystals within the pores of the masonry. The force exerted by a growing salt crystal is sufficient to disrupt even the strongest material. The term 'salt damp' is often applied to the combination of rising damp and salt attack.

## Falling damp

Leaking gutters and downpipes, and cracked joints in parapets and cornices allow rain to wash into masonry walls creating falling damp, dampness that penetrates downwards through walls, often carrying salts with it. Though generally more localised, damage to porous masonry can be just as severe as that caused by rising damp.



*Salt attack — typical damage to the base of a limestone wall. Attempts to stop the decay by patching with cement has only driven the dampness further up the wall. (Photograph: David Young)*



*Falling Damp - Severe decay of limestone due to a corroded gutter directing water down the wall face.*

*Here falling damp meets rising damp near the base of the wall. The rising damp has been made worse by the paving at the base of the wall which forces extra soil moisture up the wall and causes rainwater to splash up onto the wall. (Photograph: David Young)*

## Dealing with dampness

The following sections explain some of the key aspects of minimising salt damp problems in old walls. Work through them in the order listed, as you may find that some of the more expensive treatments are not needed.

## Good housekeeping

This means just what it says — the sensible and regular maintenance of a building to ensure that things are in good order. Check the roof drainage system — gutters, down-pipes, sumps and underground drains to make sure that water is getting away from the base of walls and not lying against them after heavy rain (for more details see technical advice sheets 1 *Introduction to good conservation practice* and 2 *Checklist for inspections*).

Check for leaking water pipes by turning all taps off and watching the water meter to see if there's any continuing usage. Get a plumber to check drains and sewers for leaks.

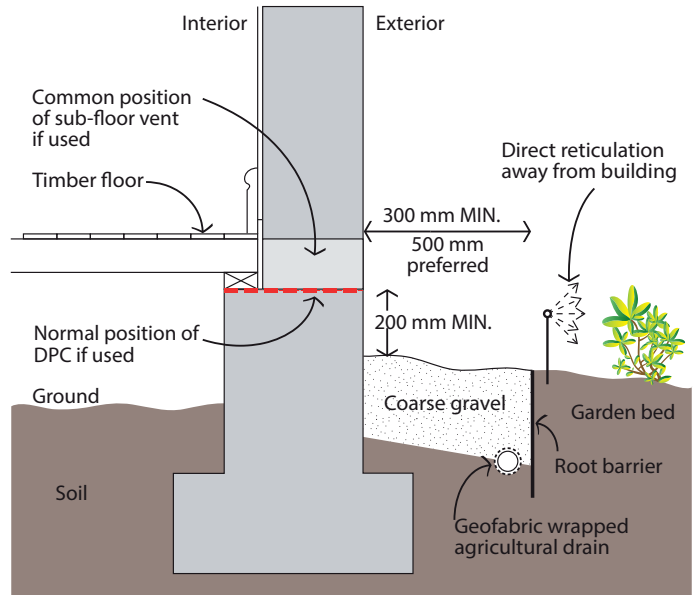
Maintain ground levels around the building so that the damp proof course (DPC), if present, is at least 200 mm above the ground, which should slope away from the walls for at least a metre. Where there is no obvious DPC use the bottom of any underfloor vents as the point to measure the 200 mm clearance from. Ground levels build up over time and so it will often be necessary to lower them and to re-arrange paving to suit.



Traditional bituminous damp proof course and underfloor ventilation in solid limestone wall.

## Allow moisture to escape from the soil

Establish a 'sterile zone' or 'breathing strip' at the base of walls on the exterior of the building to let moisture escape from the soil rather than travel into the wall by capillary action.



Garden beds should be at least 300 mm away from the base of walls and reticulation should be limited to drippers to avoid overspray onto the building. The ideal surface against the walls is porous gravel, as it will allow soil moisture to evaporate. An agricultural drain connected to a soak well can be used if required but is not always necessary in Fremantle's sandy soils. **Finished ground levels should be 200 mm below the DPC.**

## Don't water walls

Garden beds look nice against old walls and the plants hide the decaying brick and stone that they are producing. Heavy mulching may be good for the garden but is bad for walls. Watering of garden beds increases the rising damp 'stress' on masonry walls, while salts in the soils (and in fertiliser) lead to inevitable salt attack in the masonry. Floor timbers are also at risk from fungal rot, borers and termites, due to the elevated moisture levels in the wood.

Keep garden beds and plantings at least 300 mm (and preferably more) from walls. Clean excess paint, cobwebs and accumulated dust from the vent grilles that are designed to allow underfloor ventilation, so that the humidity of the underfloor spaces is kept reasonably low. Ensure that reticulation does not wet walls. Trickle drip or sub-surface reticulation is preferable to avoid overspray but if spray jets are in use, direct them away from the building and consider the effect of prevailing winds which can blow water back onto walls.

## Keep the timber floors

One of the worst mistakes of renovators is to remove a ventilated timber floor and replace it with a concrete slab poured on sand or other fill. The concrete and its associated damp-proof membrane prevent evaporation, and the soil moisture rising beneath the building becomes focused on the walls. Rising damp problems are almost guaranteed, whereas before there may have been no significant damp, even though the walls may have lacked effective damp-proof courses. External concrete paving against old walls will compound the problem.

## Maintain good ventilation

Ensure that the sub-floor wall vents are operational and clean.

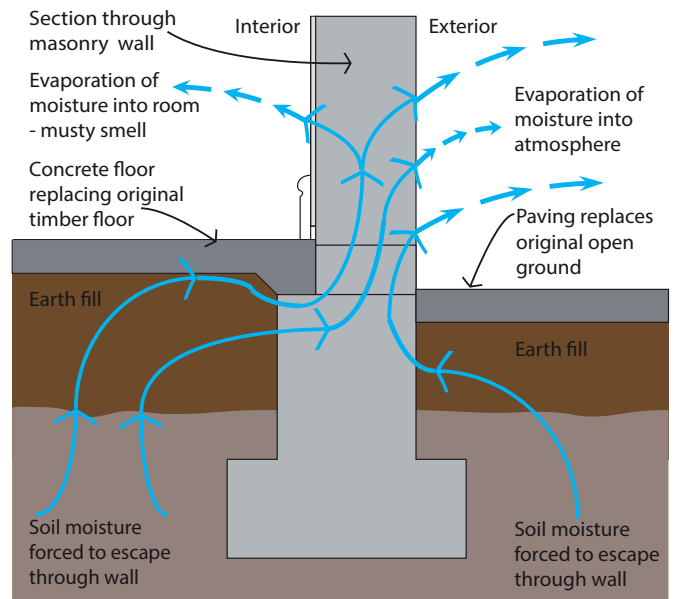
Check that the sub-floor space has good cross ventilation – vents on either side of the floor space to encourage air to flow through, taking the moist air with it.

Sometimes wind-blown sand accumulates under timber floors reducing the sub-floor space and putting timbers at risk of fungal rot and termite attack. Remove sand to a suitable depth – 400mm is generally recommended but this will depend upon the building construction.

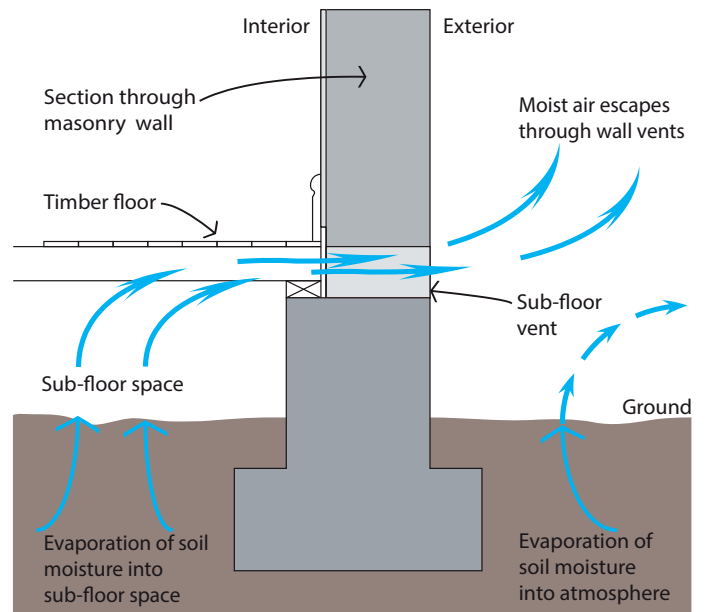
Some natural ventilation within rooms will also be beneficial to remove moisture from the air and the inner face of the walls. Keep original upper level wall vents (usually just below the ceiling) and ceiling vents open as well as fireplace openings and chimneys.



*Collapsed, rotten timber floor where external wall vents were blocked by the later addition of a concrete verandah floor.*



*Replacing a timber floor with concrete will focus soil moisture on the walls — rising damp is guaranteed.*



*A well ventilated under floor space allows moisture to evaporate to the open air.*

## Allow the walls to dry out — sacrificial treatments

Previous 'repairs' made with cement mortars and renders should be removed to allow the walls to dry out. Rake out cement pointing and decayed mortar joints to least 25 mm depth. Great care is required to avoid damage to bricks and stones. If there's substantial decay at the base of walls they may be structurally unsound — if you have any concerns consult a structural engineer (but first see *Solid walls — grouting first*, below).

There can be a considerable build-up of salts within a wall that has been sealed for many years with paint, cement renders or cement pointing. Following their removal there can be a rapid migration of salt to the wall surface as the trapped moisture escapes. It is advisable to wait for this first rush of salt and moisture to escape before repointing or re-rendering. However, where there's a lot of salt it should be captured by the techniques mentioned in the next section.

Repoint joints with well-drained lime putty and clean sharp sand in mix proportions of about 1:2½, i.e. one part lime putty to two and a half parts of sand (for details see technical advice sheet 6 *Repointing lime mortar joints*). Use a tamped finish on the joints to maximise their breathing capacity. Do not use any cement, pozzolanic material or natural hydraulic lime.

The new mortar may fail in a relatively short period (a few years) but that's the plan — for the new mortar to act sacrificially and fail in preference to the surrounding masonry. It's much easier to replace mortar than it is to replace bricks or stones. As the mortar decays, sweep up the debris and dispose of it away from the building, for it will almost certainly contain salt which we don't want to recycle through the base of the walls.

The same approach should be applied to cement renders at the base of walls — replace them with a sacrificial lime render of the same mix as the mortar. Expect it to decay and catch the debris before it is recycled through the soils. When needed, remove the decaying render and re-apply a similar render, protecting it with a limewash finish to make it last longer.



*This wall has a severe case of rising damp and salt attack and needs urgent attention. While it may seem that there is a problem with the mortar, in fact the permeable lime mortar has protected the bricks by acting sacrificially. The correct approach to repair is to repoint the joints in a lime mortar. (Photograph: David Young)*

## Removing excess salt

If there is more salt than can be successfully managed with sacrificial treatments alone there are two options:

### Captive head washing

In this system low-pressure water is sprayed at the wall inside a rubber-skirted head that is attached to a wet vacuum cleaner. The vacuum's suction draws most of the water off the wall, bringing with it loose dirt and also soluble salts from in and just under the surface. Slow passes are made across the surface and repeated several times without letting the wall dry between passes.

### Poultice

A poultice, made from paper pulp and highly absorbent material, is applied to the wall as a wet paste. Water from the poultice moves into the wall as it shrinks and dries against the surface. The water dissolves salts in the wall and then evaporates, leaving the salt behind in the poultice, which is taken off when it's dry. Several cycles may be needed depending on the amount of salt present.

Using these techniques in combination may be an effective way to reduce salt loads in old walls. Both techniques can be used together with sacrificial mortars, plasters or renders so that deeper salts, which take time to come to the surface, can be extracted.

## Inserting a damp-proof course?

Don't start here – do all the previously mentioned housekeeping and salt removal treatments first; then allow at least a year before deciding that a new DPC is needed. Often the simpler treatments are all that is required to successfully manage a salt damp problem, particularly on well-drained sandy soils along the coast and where there is an existing DPC that was 'overloaded', but may perform adequately with better housekeeping. Also, approach with caution as in some cases some types of inserted DPCs can cause more problems than they solve.

If there is no alternative, there are several ways of inserting DPCs into walls:

## Undersetting

The most expensive and disruptive is the technique known as undersetting, in which sections of the wall are removed and replaced with new materials and a new DPC is built in as work progresses around the building. Done well, this can be a successful solution to a bad damp problem, but it is the least acceptable from a heritage perspective, because of the loss of original fabric. Undersetting should only be undertaken by a builder experienced in this type of work.

## Chemical impregnation

In the widely-used chemical impregnation (or chemical injection) method, a water-repellent fluid is inserted through a series of closely spaced horizontal holes, which are drilled around the base of the wall, the aim being to form a water-repellent zone through the full wall thickness. This technique has the advantage of minimising disruption and changes to the existing fabric of the building, but its effectiveness will depend on the wall type - refer to *Solid Walls*, below.

## Electro-osmosis

Other commercial treatments include electrical methods (e.g. electro-osmosis) but their effectiveness in salt-laden masonry is not supported by the science that underlies their use in other applications.

## Which wall type?

When considering options for inserting DPCs, first determine if your building has solid walls or is of cavity construction as the method for addressing rising damp issues will vary.

Most limestone walls in Fremantle are of solid construction but brick walls can vary. To identify a brick wall's construction type look at the arrangement of the bricks. The presence of header bricks (the end of the brick) generally indicates solid wall construction. Where there are only stretcher bricks (the long face of the brick) it most likely is of cavity construction.



English bond - Alternating courses of header and stretcher bricks indicate solid wall construction.



Flemish bond - Alternating header and stretcher bricks in each course generally indicate solid wall construction.



Stretcher bond - Regular courses of stretcher bricks indicate cavity construction brickwork.

## Solid walls — consider grouting first!

Buildings constructed in Fremantle prior to the Second World War were generally built with solid external walls without a cavity.

Remember that apparently solid limestone walls may have large voids in their cores (see technical advice sheet 3 *Looking after limestone walls*). Any attempt to chemically impregnate such a wall will waste a lot of expensive fluid and is unlikely to achieve adequate penetration through the full wall thickness. You could then end up with a non-functional DPC and a large band of impermeable chemical that prevents the wall from breathing naturally.



*Cross section showing typical solid limestone wall construction. The outer leaves of larger squared stones are tied together with occasional through stones and the central core is loosely filled with small pieces of rubble and mortar — often leaving large voids.*

The problems with chemically impregnating solid limestone walls can be overcome by first filling the voids near the bottom of the wall with a lime-based grout and then drilling and injecting the wall once the grout has thoroughly hardened. In addition to damp-proofing, grouting may be needed to improve the structural integrity of the wall, particularly if there has been substantial decay and loss of stone and mortar.

A suitable grout will consist of lime putty, clean fine-grained sand, pozzolan to provide a hydraulic reaction, and plasticiser to make the grout flow into the voids. Proportions should be about 1:2, lime putty to sand, to which a pozzolan (GGBFS or fly ash) is added at the rate of about 10% (one tenth part) of the lime and casein as a plasticiser at about 5% (one twentieth part). The grout is fed into the voids via plastic tubes inserted into drilled holes. Work around the base of the walls adding only enough grout to fill 300 mm at a time. Before grouting, thoroughly pre-wet the voids with water to ensure a better cure and also to make apparent any holes that need to be plugged. Leave for three days between 'lifts' and allow at least two months of hardening before drilling for chemical impregnation.

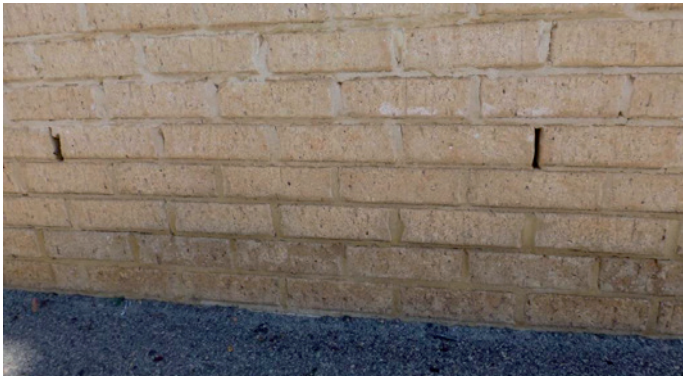
Be aware of the risks of destabilising the base of the walls: never fill more than 300 mm at a time, and always get structural engineering advice if you are concerned about the stability of any walls.

## ...and then more salt extraction

Inserting a DPC by chemical impregnation will not stop salt attack in the wall above. Once there is enough salt in a wall, damage due to the expansive force of salt crystal growth can happen simply from changes in humidity — and a new damp-proof course will not prevent that. Successful treatment of salt damp requires dealing with the salt, as well as the damp. Salts in the wall above the new DPC need to be removed and this can be done by the methods identified above — captive-head washing, poulticing and sacrificial mortars and plasters.

## Cavity walls

Cavity walls were introduced in the late nineteenth century as a way of keeping interior spaces dry. They work by allowing any moisture that gets through the outer leaf to fall down the cavity and leave the wall via weepholes left at regular intervals along the base. Never fill these holes — they're deliberate drain holes, which the wall relies on to stay dry on the inside.



Stretcher bond brickwork indicates cavity wall construction. Dark vertical slots are weepholes to allow the wall cavity to drain.

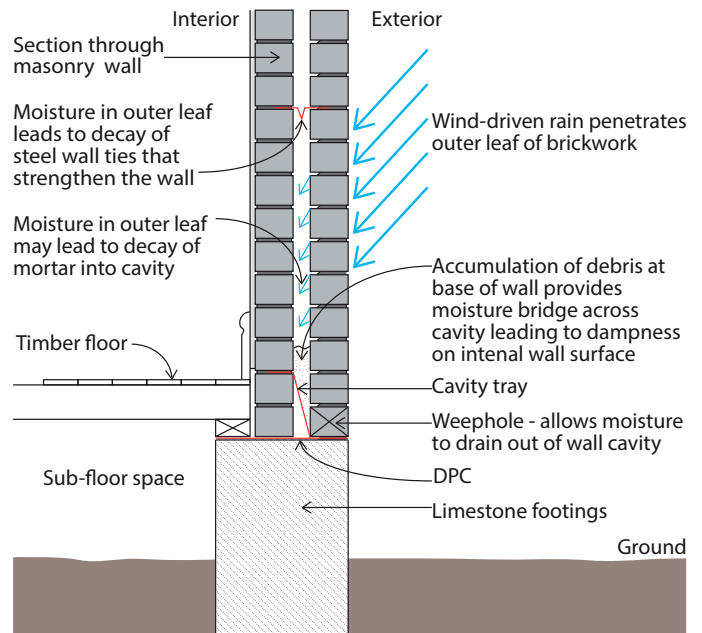
Early cavity walls can present problems if excessive amounts of moisture penetrate through the outer leaf, perhaps as a result of unfortunate sandblasting, or other high pressure cleaning, eroding mortar and the 'fireskin' of bricks. With excessive moisture carrying salts through the outer leaf, relatively weak mortars can decay into the cavity where it's not seen, and, if serious, can result in sections of the outer leaf collapsing onto the courses below.

### Check for hidden decay within the cavity

Always check the condition of the cavity, by removing the vent grilles if necessary. Clean out any mortar debris which, if excessive, will be bridging the cavity and blocking the weepholes. Use a small mirror to observe the condition of the mortar joints on the inside of the outer leaf. If bad, sections of the wall may need to be removed and rebuilt (underset) and a new DPC or cavity tray flashing inserted as part of the process.

### Check the wall ties

Also check the condition of the wire wall ties that bond the two leaves of brickwork together as moisture in the outer leaf can cause the corrosion of the ties and the destabilisation of the outer leaf. In severe conditions this can lead to the outer leaf collapsing.



Cavity walls can harbour unseen decay.



Cavity construction building where the outer leaf (painted white) collapsed because the cavity wall ties rusted away in the damp outer leaf of the wall leaving this leaf unbraced and unstable. The paint was part of the problem — had there been no paint the outer leaf would not have been so damp.



Rusted steel wall ties from the example above.

## Install chemical DPCs at the right level

A common problem with much commercial damp-proofing is the installation of chemical DPCs through holes drilled behind the skirting boards (which are removed to enable the work to be undertaken). This is convenient and involves less disruption to households. However, the correct place for inserting new DPCs is below the floor timbers, so that both the floor timbers and the walls above are protected from dampness. Doing it properly is more expensive and more disruptive, but it is the right solution for the long term.

## Always check under floors

Crumbling internal plasters that are affected by rising damp and salts are removed as part of repairs and in the process some of the debris may fall between the floorboards and the wall. That debris, laden with salt, lands on the floor plate beneath and accumulates, attracting moisture and promoting fungal rot in the floor timbers. This is an out of sight, out of mind problem, as it cannot be seen from above. Inspections of old houses should always look under the floors (through floor traps) to check the condition of the floor timbers where they meet the walls. Any debris lying on the floor plates should be cleared as part of the works.



Solid stone wall after remedial works – refer to page 2 for the 'before' photo.

While checking for debris also check that the sub-floor space is well ventilated – refer to page 4 of this technical advice sheet.

## Surface treatments to old walls

Finally, after the completion of remedial works to damp walls (both solid and cavity construction) it is important to use the right finishes to avoid undoing all your good work. Allow the old walls to breathe so that moisture can be managed by the natural system of evaporation.

## Never use cement-based plasters on old walls of limestone or soft brick

Cement plasters and patching block pores and prevent walls from breathing. Also, gypsum plasters (plaster of Paris) should not be used whenever there's a risk of moisture remaining in the walls. This is because gypsum behaves as a salt in the presence of moisture and will cause salt attack decay of the plaster.

Instead, plaster base coats should be made from lime putty and sand to which 10% of pozzolan such as ground granulated blast furnace slag (GGBFS) has been added. Alternatively, use a mortar made from natural hydraulic lime (NHL 2) and sand. Finish (setting) coats can be made with lime putty and pozzolan, or with NHL 2 to which 10–20% lime putty is added to improve workability.

## Use permeable paints

To enable old walls to dry as they were intended, we need to use traditional finishes such as limewashes which have maximum 'breathability'. Silicate-based paints may have a role in some circumstances. Do not use modern acrylic paints, as these do not have sufficient vapour permeability (breathability) for very porous materials like limestone, old bricks and old mortars. Also, beware of anti-graffiti paints and coatings as most will seal the surface of the wall.

## Further reading

Young, David. 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.

## Other technical advice sheets in this series

### **City of Fremantle Technical Advice Sheet 1**

*Introduction to good conservation practice.*

### **City of Fremantle Technical Advice Sheet 2**

*Checklist for inspections.*

### **City of Fremantle Technical Advice Sheet 3**

*Looking after limestone walls.*

### **City of Fremantle Technical Advice Sheet 4**

*Limestone walls need lime mortars.*

### **City of Fremantle Technical Advice Sheet 6**

*Repointing lime mortar joints.*

### **Look out for further technical advice sheets in this series in 2017 - 2018**

## These sheets can be downloaded from

[www.fremantle.wa.gov.au/city\\_services/planning/conservationandcareofheritagebuilding](http://www.fremantle.wa.gov.au/city_services/planning/conservationandcareofheritagebuilding)



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