

London Diocesan Advisory Committee



IN-DEPTH ADVICE SHEET: LIME

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1. LIME AND ITS USE IN TRADITIONAL BUILDINGS

The word 'lime' refers to quicklime or slaked lime, widely used to form the binder for mortars, plasters, renders and washes in traditional buildings. Quicklime is produced when limestone is heated in a kiln. Slaked lime is obtained when this is then combined with water to create lime putty (stored in tubs), hydrate (bagged as a powder) or, where the reaction takes place in sand, a 'dry-slaked' mix. Lime-based products harden by absorbing carbon dioxide from the atmosphere to revert back to calcium carbonate ('carbonation'). Chemically, this is the same as the original limestone, hence the term 'lime cycle'.

Unlike modern cement-based products, lime-based materials let structures 'breathe' by allowing water to enter and leave the walls freely as conditions vary outside. Cement and plastic based paints trap water

when it enters through cracks and they prevent it from leaving the structure, causing damp and subsequent damage.

As they are harder than most traditional materials, cements also cause "preferential erosion" whereby the softer bricks and stone will erode in preference to the cement. This is a common and unsightly feature of historic buildings which have been unsuccessfully re-pointed. Lime mortars, by contrast, are softer than most materials and will therefore erode sacrificially, keeping the original material intact.

Lime-based products are also more suitable for use in historic buildings because they allow for some movement without cracking – essential in buildings which do not have conventional foundations or contain a great deal of structural timber of mixed quality. If small cracks do appear and if little further movement takes place lime mortars and renders are capable of "autogenous" or self-healing behaviour whereby the cracks will close up as a result of some of the mortar or render being dissolved in water and therefore becoming mobile during wet weather.

Finally, the softer appearance of lime-based products is now widely considered to be more suitable aesthetically for historic buildings. This is particularly noticeable in the case of lime render when it is compared with the bleak appearance of most cement renders in both bright and damp weather conditions.

2. WHEN TO USE LIME – GENERAL PRINCIPLES

A suitable lime mortar or render should usually be used in repairs to traditionally constructed church buildings and curtilage structures, and may also be used in some extensions and even new buildings. A traditional building can be defined as a structure without a damp proof course, and / or without cavity walls, and / or with walls built substantially of traditional materials which are softer than cement based products, for instance soft red or stock bricks. This includes most buildings constructed before 1914 and some buildings built between 1914 and 1939. In some circumstances such as underpinning work or the bedding of bell frames cement mortars may be appropriate for use in traditional buildings.

3. TYPES OF LIME

There are two main types of lime used in conservation work:

Non-hydraulic lime from relatively pure limestone. This hardens only by carbonation. It is classified as CL under European standards. The purest is described as 'fat', the less pure as 'lean'. Impurities in the latter impart a slight hydraulicity, but this is not sufficient for it to be called 'hydraulic'.

Natural hydraulic lime from limestone with reactive silica and aluminium impurities. These have a harder set, as calcium silicates and aluminates form in the presence of water in addition to any calcium carbonate from carbonation. Natural hydraulic lime is classified on a scale from NHL 1 (weakest) to NHL 5 (strongest). Traditionally the two limes most widely available were NHL 3.5 NHL 5 although the more feebly hydraulic NHL 1 and 2 are now also regularly used.

While hydraulic lime is almost always supplied as a bagged hydrate to prevent it from setting in transit, non-hydraulic lime can come as a bagged hydrate or wet putty. Bagged hydrated non-hydraulic lime is the standard lime widely available in builders' merchants. Whilst this is better than no lime at all, wet lime putty is preferable because it gives a more workable mix with superior plasticity and binding properties, and is guaranteed to stay fresh.

A cement mortar containing some hydrated lime is not an acceptable substitute for a correctly mixed traditional lime mortar based on putty or hydraulic lime. Some contractors still refer to this hybrid as "lime mortar" and this should be taken as an indication that they should not be considered for historic buildings work.

The Care of Churches Team can provide advice on suitable suppliers of all the principal types of lime.

4. MIXING AND APPLYING LIME PLASTER AND RENDER

For domestic internal lime plastering use two backing coats mixed at 3 of sharp sand to 1 of lime putty, and one finish coat mixed at 2 of silica sand or silver sand to 1 of lime putty. In some churches a sandier finish coat is used on the interior giving a rougher appearance – this depends upon the size of the church as well as the aesthetic preferences of the architect and PCC.

For external rendering use two backing coats of the same mix as that used internally, but without a finish coat.

In all cases the mix should be kept fairly stiff and should have enough adhesion to stick to a ceiling if thrown. If a mix is too sloppy then it can be laid out on some plywood or a similar material to help it to dry out slightly. Conversely it is important that the mix should be workable, and this can be ensured by mixing the mortar the day before it is needed and leaving it to stand overnight. It is essential when both plastering and rendering that the background material is thoroughly wetted before each coat is applied.

The mix should be allowed to dry slowly and temperature and dampness are both important factors in ensuring this happens. The surface should be kept slightly damp for 2 – 3 days as the plaster or render carbonates, and this can be achieved by hanging a sheet of wet hessian across the completed area overnight. Lime work should ideally take place at temperatures over 8 degrees centigrade but in hot temperatures over about 28 degrees it can become difficult to ensure that it dries slowly enough. Conversely it should not be attempted when there is any risk of frost. Bearing this in mind the “lime season” for external lime work lasts approximately from late April until late September.

Hydraulic lime mixes can be varied according to the conditions but should generally be between 2.5 of sharp sand to 1 of lime and 2 of sharp sand to 1 of lime. As in the case of lime putty based mortars, hydraulic lime mortars will be easier to work if they are mixed the day before they are needed and stood overnight. They are never as workable as putty mortars, however, and for this reason they are rarely suitable for internal work.

Hydraulic limes should be used selectively in external areas which are particularly exposed or vulnerable to damp. This requires a judgment to be made based on site conditions. An area of render which is protected by a parapet above it and is not otherwise exposed to excessive damp can be rendered using a lime putty based mortar. A rendered buttress, an exposed or sloping area of render, or an area affected by a strong prevailing wind on an exposed site or an excess of vegetation which can't be removed, would probably require the use of hydraulic lime. Usually NHL 3.5 would be suitable.

The conditions in which NHL 5 should be used are relatively rare. It should be used for footings in new buildings constructed using traditional methods, or for paving work, or in renders which will be exceptionally exposed to the weather. In the latter case the permeability of the background material should be considered. For instance where the material is a hard stone such as granite NHL 5 could be used, whereas if it were soft red bricks NHL 5 would not be appropriate.

An alternative option which has recently been developed is the use of NHL 1 or NHL 2 hydraulic limes. While these will give a stronger set than putty based mortars they will not be as workable. The decision as to whether they can be used should again be made on the basis of the hardness of the background materials. A mildly hydraulic lime mortar can also be made by adding a material such as pozzolanic tile dust to a standard putty based mix.

5. SHELTER COATING

A variant on external lime rendering is "shelter coating". This is the application of a thick coating of lime render, often in several layers and usually with the intention of consolidating friable stonework. The render contains stone dust of a similar colour and type to that of the substrate. As well as improving the render's appearance this has a beneficial pozzolanic or hardening effect upon the mix. Shelter coating is often used in particularly exposed locations and it is often intended that the shelter coat should wear away over time and be replaced regularly, thus offering sacrificial protection to the underlying original material.

In some cases where the wall being protected is very uneven the shelter coat may reflect this unevenness and undulate gently around the building. Where some individual stones protrude and are still in good condition they may not be shelter coated and may instead be left as visual features. This approach is usually only taken in older vernacular buildings, and / or those in rural locations.

6. LIMEWASH AND SOFT DISTEMPER

External lime rendering can be finished with four or more coats of limewash. Limewash is a simple type of matt paint made from lime and water, with or without additives. Colours are obtained using alkali-resistant ("lime-fast") pigments, particularly metal oxides from natural earths, and these are often specific to particular regions. Pink is often associated with Suffolk, for example, and vibrant orange with the Lothians. The Care of Churches Team can provide advice on suppliers of traditional pigments. Impurities in early lime commonly produced off-white limewash without additional pigments. Historically, the terms "limewash" and "whitewash" could be interchangeable, but, more recently, the latter has referred to poor quality limewash or a white distemper.

Limewash takes less well to cement render, plasterboard or emulsion than to lime render, but may be possible to apply particularly if modified for better adhesion. Limewash is unsuitable for impervious materials (flint, hard brick, etc) and first-time limewashing is inadvisable on sandstone. Good quality limewash applied properly to a suitable substrate should not rub off readily onto clothes. Reasons for poor adhesion can be preparation with ordinary bagged lime, coats being applied excessively thickly, inadequate dampening down before limewashing, or too rapid drying out.

Limewash has many of the advantages over modern plastic-based paints which lime renders have over cements. It is considerably more "breathable" than most modern paints, can consolidate surfaces and, unlike with uniform synthetic coatings, provides attractive colour variations, especially after weathering. The alkalinity deters wood-boring

beetles and is mildly sterilising. Furthermore, limewash is inexpensive and solvent-free. The disadvantages are that much care is needed for the best results, matching coloured limewash batches is difficult, and limewashing is less successful in very fast-drying conditions.

Limewash is made by diluting lime putty to the consistency of milk usually requiring 2 or 3 parts of water to 1 part of lime putty. If you prefer not to make limewash yourself it can be supplied ready-made. Additional binders are sometimes added to limewash for improved water-shedding or adhesion, but this can be unwise without good justification. Examples are tallow and raw linseed oil but, as with hydraulic limewash, both reduce "breathability". Beware that tallow may also support mould growth without a biocide, as can casein, another possible binder.

Limewash typically requires renewing every five years. Suitable surfaces are brushed down and minor mould growth removed with fungicide. They are then dampened (normally with a hand-pumped spray) and limewash is applied thinly and worked in well, using a large, rough-textured brush. At least three or four coats are usually needed, each preceding coat being allowed to dry and the surface dampened down before the next goes on. For tinted finishes, pigment is often just added to the last coat or two. Limewash turns much lighter as it dries, so colour trials are recommended.

Internal plastering can be finished with limewash, but a traditional soft distemper would be more usual. Soft distemper is a water-based paint that primarily comprises a white base pigment (generally water-soaked whiting, i.e. pulverised chalk) bound with glue size (glue made from animal parts). This basic mix can be tinted with alkali-resistant ('lime-fast') pigments to give a wide range of colours, including blues, greens and various earth tones. Soft distemper has a velvety, matt finish and is used almost exclusively internally due to its water solubility. Soft distemper is not to be confused with oil-bound or 'washable' distemper, an oil-based water paint that was the forerunner to modern emulsion. The Care of Churches Team can provide advice on suitable suppliers of soft distempers.

7. LIME MIXES FOR NEW BRICK AND STONE WORK

When using a lime product to mix a mortar for new brick or stone work – or rebuilding of older work - the mix used should be the same as that for plasters and renders, i.e. 3 of sharp sand to 1 of lime putty, or 2 to 2.5 of sharp sand to 1 of hydraulic lime.

8. REPOINTING

Repointing is the process of taking out and replacing the mortar ('pointing') from the face of a masonry joint. Done properly, this helps

exclude the weather and retard deterioration of the wall. Regrettably, repointing of traditional buildings is commonly undertaken unnecessarily or unsatisfactorily in cement based mortars. Unnecessary repointing, especially that which uses cement, risks damage to the edges of bricks or stones as well as the loss of valuable clues to a building's construction and history.

Unsatisfactory repointing in cement can not only be visually disturbing, but harmful to the actual fabric it is intended to protect. It leads to rapid deterioration of bricks and stones as they become the most permeable part of the wall and suffer the greatest frost and salt action. Removal should only be attempted if a trial indicates this can be achieved without further damage. Otherwise, the pointing is best left to work loose.

Repointing is premature until mortar has weathered back to a depth equivalent to the joint width or is very loose. The lime mortar used for old buildings is more permeable than the brick or stone, concentrating frost and salt action in the joints. Unlike hard cementitious pointing, this protects the masonry units because the mortar erodes in preference (in other words, is sacrificial). Irregular weathering means only localised repointing is usually required. Repointing is not justified simply because the mortar is soft.

The existing pointing should usually be matched, the principal exception being where inappropriate repointing has taken place. Old pointing is often best observed in sheltered areas, such as under eaves, and should be matched in terms of material and finish. Where it is necessary to design a new mortar mix instead, this must be weaker than the bricks or blocks and take into account site exposure. If in doubt about the joint profile, a flush or nearly flush finish is frequently appropriate. The production of mortar samples and trial panels is strongly encouraged. The basis of a lime mix for re-pointing should be the same as that for brickwork described above, bearing in mind that the largest particle of sharp sand should not exceed one-third of the joint's width.

Unless a specialised form of pointing exists, a flush or nearly flush finish will often be sympathetic. Many now favour finishing joints with a fuller profile than in recent years, following historical precedent and providing better protection to the wall. Consequently, recessed pointing, particularly with stonework, may soon be considered a late-20th-Century fashion. Sometimes, though, there may be a case aesthetically for pressing the mortar back, as when repointing very localised areas or where bricks and stones have heavily eroded edges and joints would otherwise appear excessively wide.

A high proportion of failures occur because adverse weather is ignored. Where possible, as with lime rendering avoid repointing in winter.

Whatever the time of year, ensure new work is adequately protected from frost, rapid drying (by the wind or sun) and rain. Poor preparation also causes failure. Existing mortar should normally be raked out to a depth equivalent to twice the joint width (and deeper with wide joints) and the background substrate wetted thoroughly before work begins.

9. SAFETY

Given lime's reactive properties when mixed with water its use carries obvious safety risks. Spillages on to skin should be washed off immediately with soap and hot water. Eye protection and gloves should be worn when mixing bagged hydraulic or hydrated lime, and when mixing and applying limewash. Any splashes into the eyes should be treated immediately with an eye bath for 10 – 20 minutes and medical attention sought if necessary.

10. DISCLAIMER

This advice has been compiled in consultation with individuals who have expert technical knowledge in the use of lime. If followed it should result in successful lime work. The DAC cannot however give formal professional or safety advice. Responsibility for the quality of work carried out on churches in the Diocese and the safety of those involved remains therefore with the contractors who carry it out and any professionals advising them.

11. FURTHER READING

Building with Lime: A Practical Introduction. Stafford Holmes and Michael Wingate, Intermediate Technology Publications 1997

Lime in Building: A Practical Guide. Jane Schofield

Preparation and Use of Lime Mortars. The Scottish Lime Centre / Historic Scotland

The Care of Churches Team can provide advice on where to obtain these publications and on further sources of information.

12. ACKNOWLEDGEMENTS

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