



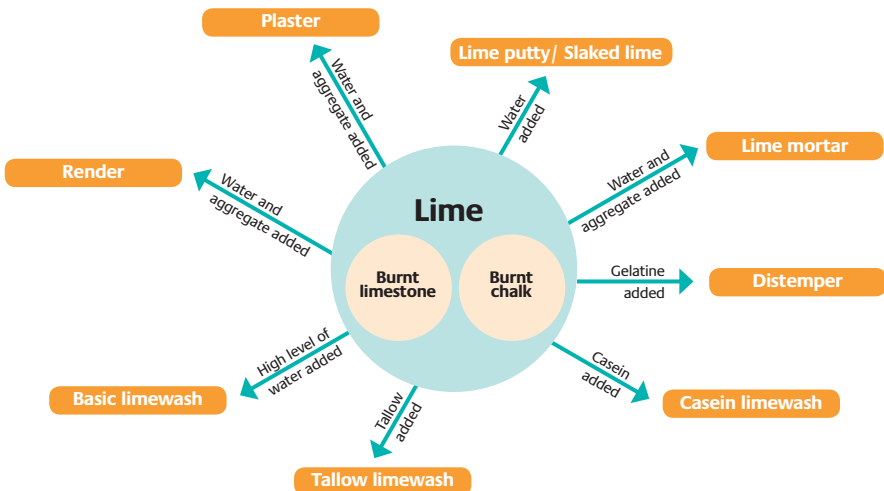
A guide to the use of lime in historic buildings

This guidance is a brief introduction aimed at householders undertaking works to their own home, builders and DIYers. Many of the companies which supply lime will be happy to advise further. You can get additional help and guidance from the Society for the Protection of Ancient Buildings (SPAB) or the Building Limes Forum. Details are in the appendix.

Lime has been used as a binder for mortars, plasters and renders since Roman times. Although its use declined after the patenting of Portland Cement in 1824, the appropriateness of lime for use in historic buildings is well recognised, and its use as a sustainable ‘green’ product is growing for new builds.

Lime can be used:

- mixed with sand to create a mortar for bedding and pointing masonry
- for plastering internally
- for rendering externally
- diluted with water to create a lime wash and other traditional paints



Why use lime mortar and not cement?

Over recent years cement has become the more commonly used, and therefore has become an industry standard, but lime has advantages:

- lime does not completely harden or set, and therefore allows movement to historic buildings
- cracks in lime based mortar tend to be extremely small and rain water dissolves free lime which is then deposited in the cracks allowing it to be self healing
- lime allows the natural moisture in the atmosphere to evaporate from the building, reducing the likelihood of damp and mould problems
- because it is based on stone it provides a common material for ironstone, etc and therefore it allows materials to work together, reducing the risk of differential expansion or structural cracking
- lime pointing is considered to be sacrificial and replaceable to protect the more expensive, harder to replace stone or brick
- lime has lower bond strength than cement, which means that the mortar can easily be removed

from the original brick or stone which allows these to be reused

- the manufacture of lime consumes approximately 75-90% less energy than producing Portland cement.

Cement is hard, non resilient, non permeable, comparatively non absorbent, brittle and it lacks the ability to react to changes in atmosphere. Cement pointing is harder than stone or a soft brick so

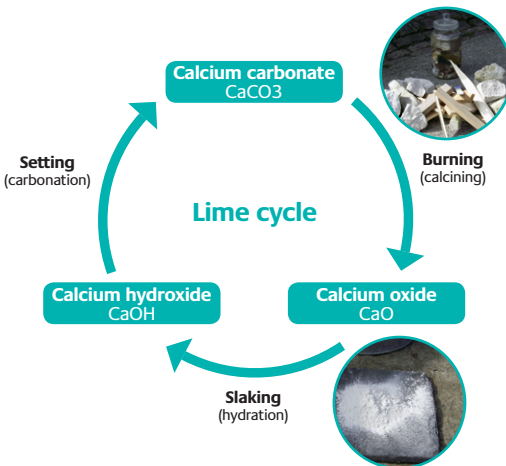
- water in a wet wall cannot evaporate from the mortar and is forced out through the face of the stone and brick, which leads to crumbling and decay of the brick or stone face
- any movement in the wall forces the masonry against the mortar, which makes the softer stone or brick crack before the mortar.



What is lime?

Lime is a natural material formed from burnt limestone or chalk. The process, known as the lime cycle, is when limestone or chalk is burnt in a kiln, forming quicklime (calcium oxide). Quicklime is mixed with water, known as slaking, which then forms lime putty (calcium hydroxide).

The lime putty which is mixed with sand/aggregates to form mortar, plaster, render or wash, reacts with the air, absorbing carbon dioxide. It starts to set (calcium carbonate), which completes the lime cycle.



Unlike cement, lime will continue to set and therefore will continually absorb carbon dioxide from the atmosphere.

Lime mortar

Lime mortar is a mix of lime and sand or aggregate. The mix varies according to the situation and the type of lime used, from high proportion of lime putty for fine work to a high proportion of sand or aggregates for robust work. A general mix comprises of one part lime to two or three parts sand or aggregate (depending on the strength required).



Lime putty, ready for mixing with aggregates



Lime mixed with sand and hair

There are two types of lime – hydraulic and non hydraulic (lime putty).

Types of lime

Non hydraulic lime is the pure form of lime putty, which is ready to be mixed with aggregates, sand and other additives.

Non hydraulic lime is usually sold in a tub or water tight container ready for use. Good lime putty should be at least six months old and look like a good cream cheese. Lime putty will settle over a period of time but it can be remixed, referred to as ‘knocking up’. The advantage of lime putty is that existing or original lime plaster that isn’t contaminated with modern products or paints can be crushed up and reused with a small amount of lime putty.



It is possible to buy quick lime ready for slaking. If quicklime is not stored correctly, it can start to slake with moisture in the air, and in some cases may actually catch fire.

The slaking of lime is a dangerous process as the chemical reaction causes heat, spitting and gasses and should only be undertaken with advice and guidance of the supplier or an appropriate professional.

Use: all work can be undertaken using lime putty, such as construction, pointing, external rendering, internal plastering and fine plaster work.

Though it can be used underwater, hydraulic lime is recommended.

Hydraulic lime contains impurities, such as clay or silicates, which allow it to set in damp or wet conditions. It comes in three strengths or grades – feeble (NHL 2), moderately (NHL 3.5) and eminently (NHL 5).

Hydraulic lime is generally sold in powder form, similar to bags of cement, ready for mixing with water.

Use: all work can be undertaken using lime putty, such as construction, pointing, external rendering, internal plastering, but is generally of a lesser quality than non-hydraulic lime.

Though it can be used for fine plaster work, non-hydraulic lime is recommended.

Both types of lime have their advantages and disadvantages

Use	Type of Lime	Strength
Mortar - exposed locations	Hydraulic	Moderately
Mortar - normal location	Hydraulic/putty	Feebly
Pointing	Hydraulic/putty	Feebly
External render	Hydraulic/putty	Feebly
Internal plaster	Putty	n/a
Fine plaster work (ie cornice)	Putty	n/a

Styles of pointing

Style of pointing	Finished appearance	Best used with	Should avoid
Flush pointing	Level with masonry	Ashlar and un-weathered masonry	Weathered masonry
Struck pointing	Angled away from lower block	Brickwork, where shadow line is sought	Ashlar, weathered brickwork and stone in general
Recessed pointing	Set back from masonry	Well weathered masonry	Ashlar and un-weathered masonry
Ribbon pointing	Set forward of masonry	-	Usage on traditional buildings



Lime plaster to ceiling and cornice detail

Matching existing pointing

When repointing an existing wall it is important to ensure that the mortar mix, including colour and pointing style matches the existing pointing, particularly where only part of a wall is to be repointed.

Specialist mortar analysis can highlight the make up of the existing mortar; however this is rarely necessary except on extensive conservation work to Grade I Listed Buildings. A close match can be made using a simple analysis of the aggregates visible in the existing

mortar. Crush up a small sample of lime mortar, shake up with water and allow settling overnight. This will result in layers indicating the mix. These can then be matched in the new mortar, adjusting the levels of each to attain a suitable colour.

Sand will vary in colour dependant on which quarry or stone it comes from and this will affect the colour of the naturally white lime mortar. It is likely that the sand used originally came from a local quarry to the building, and may still be available at local merchants.

While the mortar is wet and drying it will appear a different shade, normally darker, to the existing. If you are replacing cement or other mortars with the correct mix, this may be a different colour. New lime work will always look 'new' for a few years, but will mellow and adjust over time.

If a concrete mortar has been used it should ideally be allowed to naturally break from the masonry as forcing the mortar out is likely to damage the edges or arris of the brick or stone. Though this will mean that the building will appear scruffy for a while, the masonry will be protected for the long term. The existing pointing should be removed by hand and not by mechanical means.

A simple guide to tell whether it is lime mortar or cement is by gently rubbing a key along the surface. If little or no dust occurs, this indicates it is cement, with dust indicating it is lime mortar.



Good pointing against poor pointing

Adding aggregate or sand

Historically, aggregate would have been from locally available materials. The most common aggregate is sand in the north, and crushed limestone to the south of the county. Other materials such as ash, brick dust and coal were also used. They are rarely used these days, except in major conservation projects on Grade I listed buildings.

The choice of aggregate is important as it determines the appearance and performance of a lime mortar. The sand used in the north of the district is generally quarried in Duns Tew and has a yellow/ orange appearance which matches with the ironstone of the area. The stone dust used in the south provides a whiter mortar which blends better with the grey tones of limestone. Best

performance is achieved through the use of well graded, sharp and soft aggregates, as these interlock better, forming a stronger texture.

The aggregate should be washed as some sand has a salt residue and this can effect the binding and chemical process in the lime cycle. Pre-washed sand is available from builder's merchants.

If several coats of lime render or plaster are to be used, the sizing of aggregates should decrease towards the top layer. This is particularly important with render where the base coat is often used to build up poor substrate or brick/stone work.

It is important not to add cement into the mixture as this changes the chemical reaction, and prevents the lime from setting correctly.

Water should not be added to the mixture to improve 'workability'. Prior to starting work, allow to knock up by hand. Adding water will decrease the workability of the mixture and alter the lime cycle process.

Additional additives

Cement should not be added to a lime render or plaster, as this reduces the breathability of the lime and prevents the lime from acting as it should. It is a common misunderstanding that adding cement will make it more workable or quicker drying, but choosing the right mix will make the bigger difference.

Pozzolana was originally a volcanic dust or ground down marble which increases the setting time of lime mortars, but now refers to any material that is used to perform this function. Any additions should be recommended either by the design and conservation officer or the supplier.

Lime plaster and render

The basis is the same for both – lime. Even the aggregate or sand can be the same. The only difference is render is applied externally and lime plaster internally.

Lime renders were traditionally used to provide additional protection to walls which had been constructed of poor quality stone, porous brick or as a wet base for fresco painting. The render acts like a sponge and soaks up rainfall. The moisture then evaporates when weather conditions have improved.

In Georgian times render was used to provide a cheaper alternative to the Ashlar stone finish. This was often 'self-coloured' with either dyes or the choice of aggregates. In recent years, people have painted their properties with modern paint, preventing the building from being able to breathe, the main reason for using lime. This is because modern paints contain acrylic and this forms a fine waterproof layer which is designed to protect the material it is painted onto and to ensure the paint lasts for 5-6 years.

Modern paints can be removed by professional companies using either specialist paint removal or high pressure water in very controlled conditions. If you are willing have your home look scruffy for a while, many modern paints will blister and come away from the lime render over time and then can be removed by hand. If you prefer this method, you can touch up the gaps using a lime wash until the modern paint has gone. There are paints which you can use that allow the building to breathe. Details of these can be found in the appendix. Be careful though, manufacturers claim to have breathable paint!

What is lime render/ plaster?

A basic lime plaster or render is made in the same way as modern cement based mortar. Aggregates such as sand are added at a mixture of two – three parts of sand / aggregate to one part lime to all coats bar the last one, principally to reduce shrinkage. The size of the aggregate / sand will depend on the layer or coat of plaster.

Styles of pointing

Use	Substrate	Layer	Thickness - mix
External wall	Rough stone	Base	9mm thick - 2:5 (lime:sand)
		Top	6mm thick - 1:3 (lime:sand)
Internal wall	Laths and masonry	Base	9mm thick - 1:3 (lime:sand)
		Top	3mm thick - 3:2 (lime:sand)
Cornice, and other fine plaster work		Base	As required
		Intermediate	As required
		Top	As required

Solely fine, soft sand aggregates are recommended for decorative plaster only as they do not bind well and can cause the work to crack on a larger scale. To build up a base layer, a large stone aggregate can be used.

What about adding hair?

For centuries hair and other additives have been added to plasters and renders to give strength. It is recommended that animal hair is used although it can be from various sources. It should be strong, long and free from grease or other impurities and well mixed in the render / plaster. Most common is horse hair, though other hair can be used. Modern synthetic fibres or plant fibres have also been used unsuccessfully, and are not recommended as they are neither traditional nor reliable



due to their smoother surface.

The amount of hair necessary to provide a suitable mix depends largely on the type of hair used. A general rule 4kg of hair per cubic metre of mortar works well on timber laths. A visual guide is to hold up a trowel full of mortar and the hairs should stick out.

Where to use lime plaster and lime render

The use of lime render is relatively rare in this district. It has been used to protect the poor quality cornbrash building stone in the south and occasionally in Banbury on stucco fronted properties. Lime render is also suited to covering earth and external timber framing, of which there are a few examples within the district.

Lime plaster, being widely used as an internal finish, can be found in most traditional buildings to some degree and today still provides the most suitable finish.

Internally, a wall should have a minimum of two coats of lime. A stiffer mix directly on to the laths and a fine top mix for the finishing coat. Some walls can have three or four coats depending on the substrate. For a finer finish the final coat should be richer in lime, which can then be polished up to create a smooth finish.

If a building suffers from damp, then replacing modern plasters (such as gypsum which is normally a pinky colour) on solid walls with a lime plaster can help solve the problem. This isn't an overnight cure, but a slow process over time while the moisture evaporates.

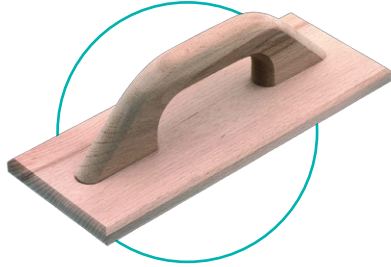
Applying lime plaster and render

First remove any loose or soft render, plaster or pointing by hand. Then brush down with a stiff brush to remove any further loose material. A good indication of live or loose plaster is that it can sound hollow when tapped.

When plastering on laths ensure they are firmly fixed and free of any old plaster. If fixing new laths, space them approximately 8mm to 10mm (finger gap) apart to allow for the scratch (base) coat to be pushed through. If narrower the 'nibs' or the 'snots' formed in the void behind will be too weak to hold the weight of the plaster and if larger the nibs or snots themselves will be too heavy.

The substrate, either timber, brick or stone, should be dampened before lime is applied. This allows the existing surface and the new to dry together, stopping cracks and/ or weaknesses in the bond.

Applying lime is the same as modern plasters and renders, though it is traditionally applied with a timber float rather than a metal float. The finish of lime plaster can be as smooth as modern materials, though many people prefer a softer appearance.



It is important not to overwork the lime which draws the lime to the surface, giving it a whitish appearance.

Applying lime render or plaster to a smooth surface, such as plywood or plaster board should be avoided as there is little key for the render/ plaster to bond to. Chicken wire, metal or plastic laths can be used but should be avoided as they are likely to fail over time due to the thermal properties of the metal being different to that of the render or plaster. The amount of moisture retained in the render or plaster will cause metal work to rust leading to large scale failure. It may be acceptable in certain locations to use stainless steel expanded metal laths to undertake localised repairs, reducing the disturbance to original plaster.

All finished work must be protected to prevent rapid drying in the summer and hard frost in the winter. Lime plaster and render generally dries unevenly and patchy as the



Laths fixed ready for plaster and nibs, hooking over the laths holding the plaster in place

moisture is slowly released. If one area dries a lot quicker than others, allow to gently dampen with a fine mist sprayer to ensure that it dries fairly evenly to prevent cracking and later failure of the plaster.

During the drying process it may be required to ‘push back the plaster’ which is trowelling over the wall again. It is important before doing this to slightly dampen the plaster or render.

When using lime mortar externally in winter or in frosty conditions, the walling should be protected (with hessian or other heavier material) from frost until the lime is dry to touch. In the summer, to protect from drying too quickly, it should be protected with dampened hessian or other heavier material. If the lime does become damaged,

it will require removal of the mortar, which can be remixed and reapplied.

Lime render or ‘stucco’ is often finished with ruled lines pressed into the damp render to create the illusion of ashlar stone.

Repairing lime plaster and lime render

The careful selection of matching aggregates can lead to the successful repair of existing renders and plasters, without the need for a complete removal. Hollow or detached work can sometimes be saved by installing ties to bind the work, however this would only be required where the existing render or plaster is of considerable age or of historic importance. It is a difficult

process and specialist advice should be sought prior to any undertaking.

Where patches are to be repaired the existing render or plaster should then be cut to form a square edge so that the new work can be butted directly to it. The retained work should also be dampened to reduce the risk of cracking along the joint upon hardening.

Lime wash and distemper

Internally both lime washes and distempers were used to decorate the walls of even the most ordinary home, dating back to wall paintings and decorative schemes of the 15th century.

Basic lime wash is made by adding water to lime putty to produce a thin paint of brushable consistency. Lime wash was traditionally used externally in Cherwell to protect the Cornbrash rubble in the south.

Lime wash is compatible with a wide range of building surfaces, including brick, stone, timber and plaster, both internally and externally and it has a vapour permeability of at least ten times that of modern resin paint. A binder is added to allow adhesion to these alternative sub bases.

The two most common binders are tallow, a type of animal fat and casein, the solid element in milk.

Distemper is generally used internally, in particular ceilings, cornices and other fine plaster work. It comes in two main forms, 'glue bound distemper' lime mixed with gelatine or synthetic glues and 'oil bound distemper' lime mixed with oil, normally borax.

Distemper cannot be painted over with any other type of paint finish, and therefore it is recommended to continue using distemper as a decorative finish.

Both finishes allow the building to continue to breathe and flex as originally intended.

Lime wash and distemper

Product	Properties	Use
Basic limewash	Limited binding properties	Can be used on damp substrates as it has a high tolerance to moisture
Tallow limewash	Less porous than other forms of limewash	On interior or exterior, but more popular for external use. Brushes off onto clothes making internal use unpopular
Casein limewash	Improved binding capacity over basic limewash. Susceptible to mould formation	On interior or exterior, but is popular for interior use as it adheres better and is more porous
Hydraulic limewash	Higher resistance to moisture	Good in wet conditions as sets by chemical reaction with water
Glue bound distemper	High vapour permeability. Cannot be washed down, but is easily marked and discoloured	Good for use on occasionally damp surfaces, but not on continually damp surfaces as the binder fails over time. Can be used on plaster, wallpaper or painted inside surfaces. Favoured for use on ceilings
Oil bound distemper	More durable than glue bound and is often washable. Less porous than limewash, retains excellent porosity	Suitable for a variety of internal surfaces including timber

Applying lime wash and distemper

The surface to be painted should be brushed down with a soft brush, with any loose plaster or timber made good, and then dampened. The easiest way to do this is with a

garden sprayer on fine mist.

Lime wash and distemper are applied in thin layers with a brush. Thick layers should be avoided as they tend to craze and crack on drying.

Pigments and colouring materials can be added to both lime wash and

distemper, but externally coloured lime washes are rare within the district.

To build up a solid colour or white wash may require up to 20 coats but it is usual to apply between 12 and 18 coats. Each coat should be allowed to be touch dry before applying the next coat.

Lime will change colour when drying, so it is advisable to do a test patch first. It will also darken when it become wet again, particularly externally. This is nothing to be concerned about as it is part of the beauty and quality of lime wash.

Listed building consent

Undertaking repair works to a listed building does not require listed building consent, but when does a repair turn into new work or replacement?

Consent is not normally required for repairs to listed buildings if the work is identical in materials, techniques and design. However, if you plan to change the colour of the windows, remove the paint from the external elevation, clean the stone or remove and re-plaster a complete internal wall, consent will be required.

If more than 25% of the material or fabric of the building is removed as part of the works, then consent would be required as a significant proportion of the fabric is affected.

If you have an unlisted building in a conservation area, conservation area consent may be required.

To apply for listed building consent, the following is required:

- application form – available to download from Cherwell District Council web site www.cherwell.gov.uk
- site plan showing boundary of ownership and the building the application is regarding
- design and access statement
- heritage assessment
- heritage impact assessment
- drawings showing proposed work – scale and detail dependant on application
- any further information you may feel relevant.

We may attach a condition to a consent requiring a sample panel to be undertaken for approval prior to works commencing.

Undertaking works which are more than repair and maintenance works without consent is a criminal offence under the Planning (Listed Buildings and Conservation Areas) Act 1990.

In exceptional circumstances, if it is deemed that the historic plaster is of significance, we may allow careful over boarding with thin plasterboard to form protection for the plaster.

If your property is listed, then the whole building is protected by law, internally and externally, including any fixtures and fittings, associated outbuildings and connected walls.

Use of lime on new buildings

Lime is not just useable on old buildings, but is a renewable material that also takes in carbon dioxide from the atmosphere. Lime's 'green' credentials are extremely good as the product not only stores carbon dioxide from the atmosphere, it can be recycled and the carbon footprint to produce lime putty is lower than most modern products by at least 75 to 90%.

New buildings, or extensions to historic ones, can be used with green materials, such as hemp or straw bales. Many of these products are either carbon neutral or negative carbon bio-composite wall system comprised of hemp and a lime based binder, with excellent thermal properties.

Instead of concrete floor slabs, limecrete can be used. It provides a warmer-to-feel floor than concrete and has lower embodied energy.

Using lime with other natural products achieves the best BREEAM rating and Code for Sustainable Homes, with a low embodied energy and energy performance.

Suppliers

IJP Conservation Ltd, (Old House Store)

Hampstead Farm,
Binfield Heath, Henley on
Thames, RG9 4LG
Phone 0118 969 7711
www.oldhousestore.co.uk

Traditional Lime Co

Church Farm,
Leckhampton,
Cheltenham, Gloucester,
GL51 5XX
Phone 01242 525444
www.limemortars.co.uk

HJ Chard and Sons

Albert Road, Bristol, BS2
OXS
Phone 01179 777681
www.hj-chard.co.uk

RH Bennett, The Lime Centre

Long Barn, Morestead,
Winchester, Hampshire,
SO21 1LZ
Phone 01962 713636
www.thelimecentre.co.uk

The Real Paint and Varnish Co.

Little Asby, Cumbria,
CA16 6QE
Phone 01539 623662

Rory Young

5 Park Street,
Cirencester,
Gloucester
Phone 01285 658826

Trevor Dean

2 Peacock Cottages,
Oxhill, Warwickshire
CV35 0QV
Phone 01295 680474

Paul Smoker, CY-Pres

14 Bells Close,
Brigstock, Nr Kettering,
Northamptonshire,
NN14 3JG
Phone 01536 373158

Rose of Jerico

Horchester Farm,
Holywell, Nr Evershot,
Dorchester, Dorset.
DT2 0LL
Phone 01935 83676
www.rose-of-jericho.demon.co.uk

Mike Wye Associates

Buckland Filleigh Sawmills,
Buckland Filleigh, Devon,
EX21 5RN
Phone 01409 281644
www.mikewye.co.uk

Building Lime Co

Lime Stuff Ltd, Unit
12, Glendale Farm,
Southampton Rd,
Whiteparish, Salisbury,
Wiltshire SP5 2QW
Phone 01794 884294
www.buildinglime.co.uk

Chalk Down Lime

The Lime Yard, Northiam
Road, Staplecross, Nr
Robertsbridge, East Sussex
TN32 5RP
Phone 01580 830 092
www.chalkdownlime.co.uk

Sources of information

Society for the Protection of Ancient Buildings

www.spab.org.uk

Building Limes Forum

www.buildinglimesforum.org.uk

British Lime Association

www.britishlime.org

General advice -

Buildingconservation.com

Publications

www.limetechnology.co.uk/pdfs/NHBC_lime_mortar_guide.pdf

Published by ITDG publishing

www.spab.org.uk

- NHBC Foundation: The use of lime based mortars in new build.
- Building with Lime: Stafford Holmes and Michael Wingate
- An introduction to Building Limes: SPAB Information Sheet.

PLAN0112

Glossary of terms

Aggregate: material added to plaster, render, mortar etc to provide additional strength

Lime: limestone or chalk burnt in a kiln

Lime putty: slaked lime in its liquid state

Nib: hook created in void behind a lath and plaster wall which holds the plaster to the wall

Scratch coat: the first plaster or render coat

Slaking: adding water to lime

Stucco: render on external elevations of a building, often made to look like Ashlar stone finish.

Unslaked: lime which has not been added to water

Call **01295 227006**
or visit **www.cherwell.gov.uk**

The information in this document can be made available in other languages, large print braille, audio tape or electronic format on request. Please contact 01295 227001

Jeżeli chcieliby Państwo uzyskać informacje w innym języku lub w innym formacie, prosimy dać nam znać. 01295 227001

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