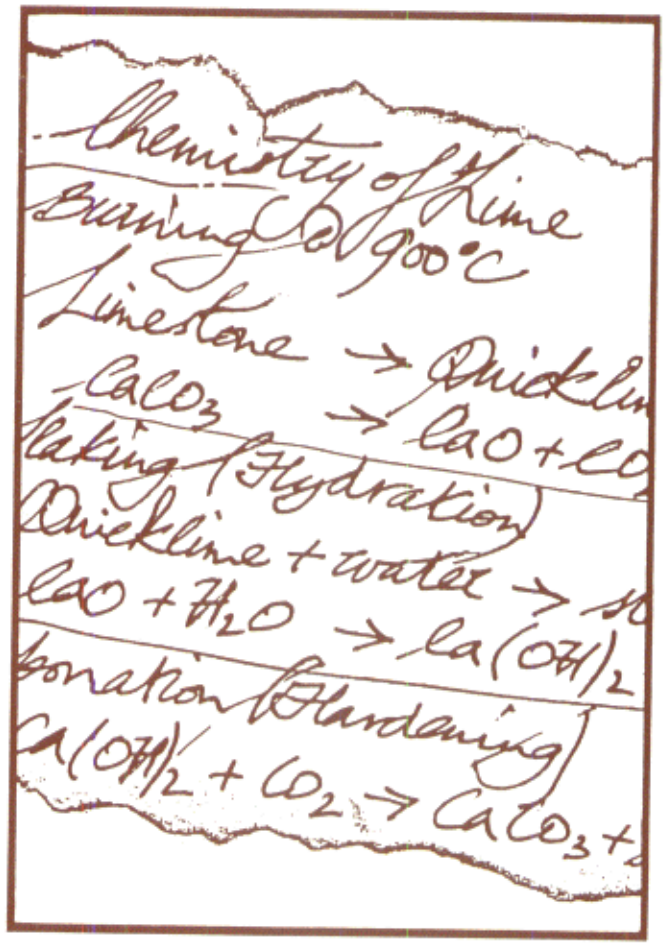
LIME



A GUIDE TO THE USE OF LIME IN HISTORIC BUILDINGS

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Conservation and Environment Unit

LIME

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INTRODUCTION

Lime is the principal binder of most traditional mortars, plasters and renders. It tends to be neglected in modern building practice, but it is central to successful maintenance and repair of traditional buildings and natural stonework. An understanding of lime is essential for anyone working on historic buildings.

Lime has had a long history of use for building in Britain. The Romans employed it in their construction operations and it was used extensively in mortars and surface finishes from then until the nineteenth century when patent cements, such as Portland Cement, were introduced. The use of lime declined in the twentieth century, but increasingly it has been recognised that hard, cement-rich mortars are unsuitable for use on old buildings, and lime is enjoying a revival. However, much of the skill and knowledge needed to use lime successfully had nearly died out so when lime began to be more widely demanded in conservation work there was often a lack of suitably experienced specifiers and skilled craftsmen. In fact, the practical techniques required for the use of lime can be mastered by anyone with good building skills or a craft aptitude, but what is essential for success when using lime is a thorough understanding of how the material works and the adoption of certain basic principles when using it.

This booklet explains how lime works, why it is of such benefit in maintaining and repairing historic buildings and aims to give guidance in using lime. It may be useful to owners of historic buildings who lack the confidence to use lime themselves or who would like to know more about it before instructing a builder to use it. It may also be handy for builders who are unfamiliar with lime, and serve as a reminder for those who have not used it for years.

The advice given in this publication will apply to many repair and maintenance problems encountered in historic buildings in South Somerset but it does not cover every eventuality. If you have a special case, such as surviving medieval render, stonework with very fine joints or decorative plasterwork for example, or if you have any doubts you should seek further information before embarking on a project. The best way to learn about using lime is to have some form of practical demonstration or training. The Historic Buildings Advisor in the Conservation and Environment Unit can provide further information, including names of specialist individuals and organisations offering advice, training and demonstrations. No responsibility can be accepted for unsuccessful work following the advice in this publication.

APPLICATIONS

Lime is used in buildings in many different ways. Lime putty mixed with sand to form lime mortar can be used for bedding masonry and for pointing, rendering and plastering. For the very fine joints in ashlar masonry pure lime putty was sometimes used. Lime putty can be diluted in water to make limewash for painting both internal and external walls. A colourwash can be made by adding pigment.

Lime putty is mixed with carefully chosen sands and stone dusts to make repair mortars for damaged stonework. Lime also has valuable applications for specialist stone cleaning and conservation techniques.

WHY USE LIME MORTAR?

Traditional building construction in South Somerset is based on the use of relatively soft and porous materials such as stone, brick, timber and cob, together with a lime based mortar for bedding and plastering. These buildings usually have solid walls, with no cavity, and are often built on insubstantial foundations. They are therefore liable to settlement and movement associated with seasonal changes in ground conditions. Lime mortar is softer and weaker than the stone or brick which it bonds and is therefore able to accommodate slight movements caused by settlement or temperature changes without significant cracking. Also, it is permeable and allows evaporation of rising and penetrating damp from within the wall. It is this permeability, or 'breathing', which helps to keep the building dry inside without a damp proof course or chemical treatments.

WHAT IS WRONG WITH CEMENT MORTAR?

Modern cement pointing is very different from lime mortar. It is hard and brittle, much less porous and sometimes completely water-proof. Its use on traditional masonry is damaging in several ways.

Cement pointing is harder than soft brick or stone and is too rigid to accommodate settlement or movement in the wall. When movement occurs the edges of the stone or brick are forced against the hard mortar spalling the masonry and cracking the mortar itself.

Further damage is caused by rainwater seeping into the cracks in the pointing and around the edges of the stones. Because the mortar is not permeable this moisture cannot evaporate from the mortar joint once rain stops. Instead it is forced to evaporate through the face of the brick or stone and soluble salts present in the water crystallise in the surface layers of the masonry leading to crumbling and decay. This is sometimes so severe that the entire face of the stone is lost and the hard cement pointing is left standing proud. Further rainwater is trapped and the decay continues. The concentration of trapped water in the masonry also increases its susceptibility to frost damage in winter.

In contrast soft lime mortar allows moisture movement and, being more porous than the masonry, encourages evaporation and salt deposition in the mortar joints. Thus it is the mortar which decays and not the stone or brick. It is much easier and cheaper to repoint a wall than to repair or replace damaged brick or stone, and there is less loss of important historic fabric.

Cement render causes slightly different problems. Hairline shrinkage cracks inevitably form in the surface of the render as it sets or afterwards by slight movement in the wall. Rainwater is drawn by suction into these cracks and then diffuses into the wall. Once inside the wall this moisture, together with any rising damp, is trapped as it cannot evaporate through the hard, impermeable render. Moisture levels start to build up in the wall and the moisture tends to diffuse towards the inner surface of the wall resulting in internal dampness and damage to plaster and decorations. So, strange as it may seem, applying a waterproof render can actually increase levels of damp inside the house. A porous lime render encourages evaporation of moisture from its surface, helping to minimise the effects of penetrating and rising damp.

HEALTH AND SAFETY

All lime and lime mortars are caustic and can dehydrate the skin. When using lime it is advisable to wear gloves, protective overalls and goggles and, if working with lime for prolonged periods, to protect exposed parts of the body with barrier cream. Goggles should always be worn if there is a risk of splashing from lime putty or lime wash. It is very easy to flick lime into your face when scooping lime putty or mortar out of a tub.

When using dry hydrated lime or quicklime goggles and a dust mask are essential to prevent the dust, which is particularly harmful, getting into the eyes and lungs.

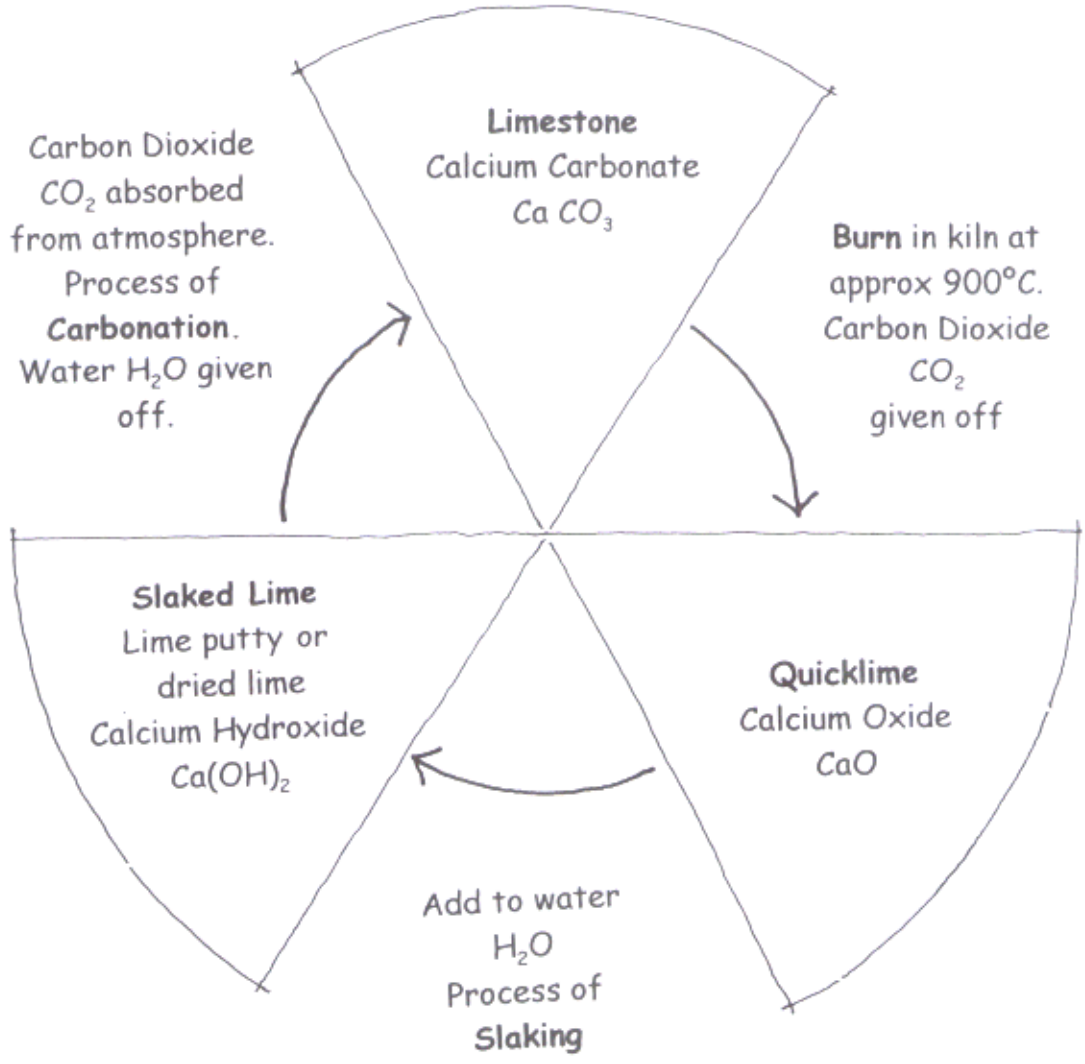
Quicklime is extremely hazardous. It reacts very violently when it comes into contact with water, moisture or sweat, generating boiling hot temperatures. It should never be handled with bare hands or wet tools. When slaking quicklime protective clothing, gloves and goggles must be worn. Quicklime should be stored and slaked away from combustible materials. Do not slake your own quicklime unless you know exactly what you are doing.

When working with lime a supply of clean water should be close at hand and all lime on the skin should be washed off as soon as possible. Lime in the eye should be removed immediately and the eye washed out with clean water (preferably distilled) for at least 20 minutes. An eye wash bottle will make this easier. In any severe cases medical attention should be sought.

MATERIALS

LIME

Lime used in building is made from chalk or limestone (calcium carbonate) burned in a lime kiln to form quicklime. The quicklime is added to water in a process known as slaking to form a creamy lime putty. Lime putty is mixed with sand to form lime mortar, or with water and pigments to make limewash. Lime mortar and limewash harden by a chemical process called carbonation as water evaporates and the lime reacts with carbon dioxide in the air. During each of these processes the lime undergoes a chemical change but the final stage, carbonation, converts it back to calcium carbonate which is chemically and physically similar to the original limestone. This is known as the "lime cycle".



The Lime Cycle

There are two basic types of lime; hydraulic lime and non-hydraulic lime. Both can be used as either wet putty or dry powder.

The term "hydrated" is often used when referring to lime and there is sometimes confusion about the differences between hydraulic lime and hydrated lime. "Hydraulic" refers to types of lime which set partly due to a chemical reaction with water. They can therefore harden even underwater.(The setting of hydraulic lime is much more complicated than is shown in the lime cycle above). Non-hydraulic limes require the presence of air in order to set and will not harden underwater. The term "hydrated" simply refers to any type of lime, hydraulic or non-hydraulic, which has been slaked. The terms "hydrated lime" and "slaked lime" mean exactly the same thing. However, many people use the term "hydrated lime" to describe only the dry, powdered non-hydraulic lime sold in bags at builders merchants. This is misleading since non-hydraulic lime putty, hydraulic lime putty and dried, slaked hydraulic lime are also hydrated limes. It is less confusing to learn and use the correct terminology which describes the material more precisely.

Non-hydraulic lime

The lime most commonly used for conservation work today is non-hydraulic lime, which may also be referred to as high calcium lime, pure lime or fat lime. It is available either as a dry powder or as a sticky lime putty. Both are chemically the same (calcium hydroxide) and are made by slaking quicklime (calcium oxide) in water. The dry powder is made under carefully controlled conditions which ensure that there is no excess water once slaking is complete, whereas lime putty contains more water than is necessary for complete slaking.

The excess water protects the lime putty from reacting with the air so it can be stored indefinitely without hardening. In fact the longer it is stored the better it becomes. This is because storage ensures thorough slaking and because the lime continues to absorb water into its structure. This increases the plasticity of the lime allowing a closer contact with the sand grains when it is used for mortar, enabling a better bond between mortar and masonry. Lime putty should be stored for at least one month before use, and ideally for at least three months. The longer it is stored the better, and for the best work use putty which is six months or one year old. Lime putty should be stored in airtight conditions, protected from frost.

Dried lime on the other hand starts to deteriorate from the moment it is made. As a powder it has a large surface area which, when exposed to the air, results in partial carbonation of the lime even before it is used for making mortar. Therefore it cannot create such an effective bond with the sand or masonry. Its properties improve a bit if it is mixed with water and stored for at least 24 hours before use, but for best results use good quality, mature lime putty not hydrated lime powder.

Non-hydraulic lime is suitable for use with the traditional building materials of South Somerset such as stone, clay brick and cob, in a variety of situations.

Hydraulic lime

Hydraulic limes are made by burning limestones which contain impurities, particularly minerals such as silica, alumina and iron oxides, to form hydraulic quicklime, which is slaked in a similar way to non-hydraulic lime. Hydraulic limes undergo partial hardening by reaction with water so, unlike non-hydraulic limes, they are capable of setting underwater. This setting property derives from the presence of the impurities which, once slaked, react with the lime in the presence of water forming solid crystals. The proportion of these minerals occurring in the limestone affects the strength of the lime and the speed with which it will harden. A low proportion of impurities will produce a feebly hydraulic lime whereas a higher proportion will yield a moderately or an eminently hydraulic lime. Some hydraulic limes are so strong and quick setting that they are referred to as natural cements. A recent European standard for classifying hydraulic limes is rapidly replacing the old classification. Natural hydraulic limes are now designated as NHL with the terms 'feebly', 'moderately' and 'eminently' replaced by the suffixes '2', '3.5' and '5'. So, for example, a feebly hydraulic lime would be designated NHL2.

Because hydraulic lime starts to harden by reacting with water hydraulic lime putty must be used soon after slaking and cannot be stored for long periods. However hydraulic lime is usually supplied in powder form which, if kept airtight and dry, has a longer shelf life.

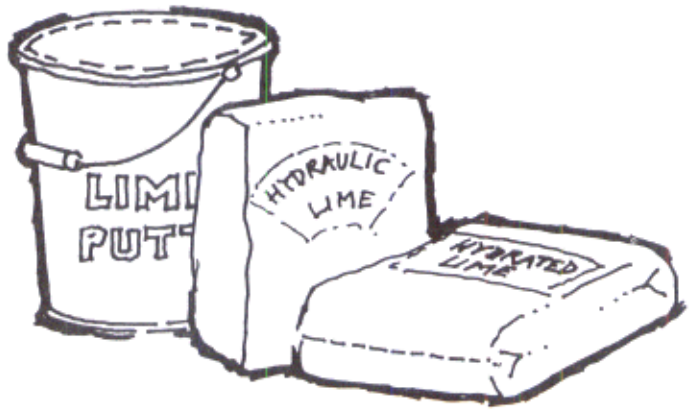
Blue Lias limestone, which is widely used for building in South Somerset, was historically an important source of hydraulic lime for building mortars, and virtually all traditional buildings in this area would have been constructed using lias lime. Its use declined and eventually ceased during the twentieth century but it is now manufactured in Somerset once again. The only other source of hydraulic lime in the south west is Shillingstone in Dorset where a feebly hydraulic quicklime can be obtained. Dried hydraulic limes are also imported from France, Switzerland and Italy.

Hydraulic lime is suitable for use with moderately durable stone and brick, especially in exposed conditions. As it may be stronger than non-hydraulic lime it may not be suitable for use with very soft, weak materials such as cob and decayed stone or brick.

Suppliers

If you ask for lime at a builders' merchant you will almost certainly be offered dried non-hydraulic lime sold in bags. However good quality non-hydraulic lime putty is superior and should be used wherever possible. Non-hydraulic lime putty and dried hydraulic lime are available from an increasing number of specialist suppliers, some of which are listed at the end of this booklet, but they are rarely available from builders' merchants. Lime putty is usually supplied in plastic tubs in which it can be stored indefinitely if protected from frost. It should be matured by the supplier for at least one month before sale, and most suppliers also stock three month old putty. Check the age before buying. Lime putty can be stored for years, improving all the time.

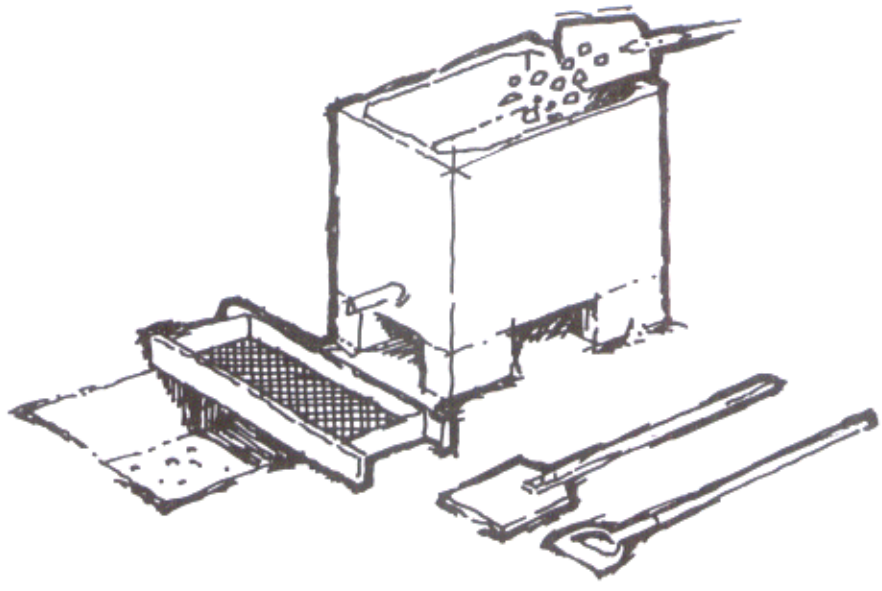
Alternatively, you can make your own lime putty by slaking quicklime as described below, but unless you are know exactly what you are doing it is best to buy ready slaked lime. Quicklime is usually only available direct from the quarry or plant where it was burned. For suppliers see the list at the end of the booklet.



Slaking lime

Slaking quicklime causes a violent reaction during which a great deal of heat is generated and the lime may pop and spit. It is a dangerous operation and safety precautions must be taken. Protective clothing, including waterproof jacket and trousers, gloves and boots should be worn and eyes must be protected with goggles. Anyone not protected in this way should keep clear of the slaking tank. The procedure is the same for both hydraulic and non-hydraulic lime.

- Quicklime should be slaked in a metal tank such as an old galvanised water tank, metal bath or feeding trough. For small quantities a galvanised metal bucket or dustbin can be used. Plastic should never be used because the heat generated may melt the plastic. If using a tank or bath with a plug hole it should be fitted with a bung and supported on bricks or blocks so that it can discharge into a suitable storage container. Traditionally this would have been a wooden lined pit dug in the ground but nowadays plastic tubs, dustbins or skips are used.

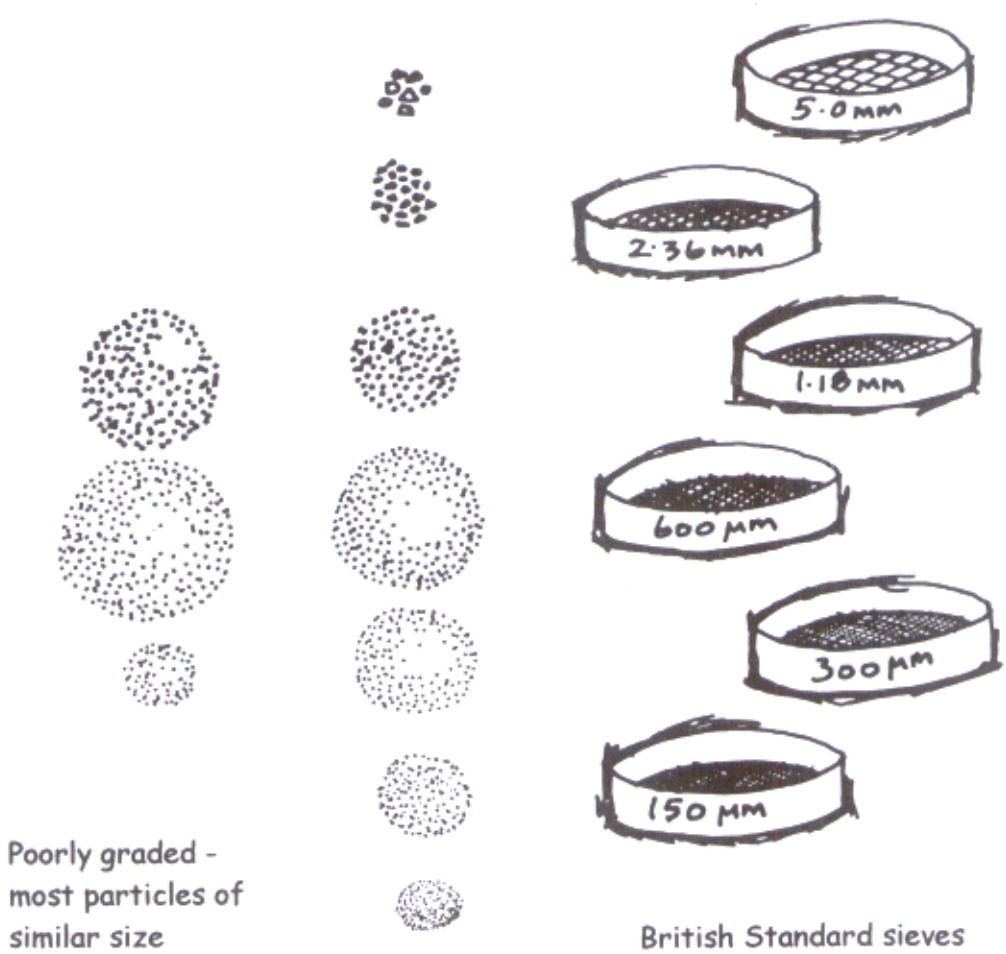


• Fill the tank with clean water to a depth of about 12 inches and add the quicklime a bit at a time using a shovel. Always add quicklime to water rather than adding water to quicklime which will cause an explosive reaction. The amount of quicklime to use can best be judged by experience but as a rough guide use 1 volume of quicklime to 8 - 10 volumes of water. Fresh, non-hydraulic quicklime will react vigorously with the water generating a great deal of heat. As the mixture boils it should be stirred and agitated using a long wooden paddle, rake or hoe to prevent lumps of quicklime from being encased in slaked lime which would halt the reaction. Older non-hydraulic quicklime and some hydraulic quicklimes will be more sluggish and the reaction can be speeded up by using hot or boiling water and by lightly crushing the first few shovel-fulls of quicklime. Keep stirring from time to time until the visible reaction stops. Add more water if the mixture starts to become dry and crumbly. You should be left with a thick creamy mixture with a few bits of grit and gravel at the bottom. Leave to cool.

• Release the bung and allow the milky lime to pour into the pit or storage container via a sieve (2.36 mm mesh, or 10 holes to the inch) to collect the grit. If using a bucket or dustbin for slaking carefully pour the lime through a sieve into the storage container. The lime will settle out to form a mass of lime putty with a layer of water on top. The water protects the lime from the atmosphere preventing it from hardening. Store the lime putty under water in a sealed tub for at least 1 month, and preferably for three months, before use.

AGGREGATES

The choice of aggregate is important in determining the appearance and performance of the lime mortar. Aggregate adds bulk to the lime and acts as a filler, helping to reduce shrinkage of the lime as it dries out. This is best achieved using a well-graded, sharp aggregate. This means that the particles are angular rather than rounded and that there is a range of particle sizes, incorporating both fine and coarser particles. Such aggregates will interlock well, the smaller grains filling the spaces between the larger ones. Aggregates where the particles are all the same size or are soft and rounded do not interlock to the same extent and will form less cohesive mortars. If you scoop up a handful of sharp, well-graded sand and clench your fist you will feel the sand grains interlock forming a solid mass in your hand. If you do the same with a soft or poorly-graded sand it will feel much less solid and still feel liable to "give" in your hand. This is a useful test when buying sand. You can also use a x10 hand lens to look more closely at the angularity of the grains and the range of grain size.



Poorly graded -
most particles of
similar size

British Standard sieves

Well graded -
a range of particle sizes

A well-graded aggregate will also impart a stronger texture to the mortar than one with uniform particle sizes. The texture of the mortar should reflect the type of masonry being repointed. Masonry with fine joints should be pointed with a fine aggregate whereas wider jointed masonry usually looks best pointed with a coarser mix. Most historic mortars are composed of whatever aggregate was available locally and many have a higher proportion of fine particles than would be recommended today. Although it is usually desirable to try to match the texture of the original mortar when re-pointing care should be taken to avoid reproducing mortars which are too fine and may not perform well.

The particles in a well graded, sharp sand will interlock to form a strong mortar

Rounded or poorly graded sands form weaker mortars

The colour of a mortar is influenced by the choice of aggregate. However, lime tends to whiten any aggregate with which it is mixed so that lime mortars are traditionally pale cream or buff. When carrying out re-pointing or re-rendering it is usually best to try to match the colour of the original pointing rather than that of any later work. Only rarely is a strongly coloured mortar appropriate so artificial pigments are very rarely needed.

The most common type of aggregate is sand, sometimes with the addition of grit where a coarse aggregate is needed. The sand should be well washed to remove impurities such as clay, salts and organic matter which could all affect the performance of the mortar. They should then be stored away from possible contamination by soluble salts, and ideally in dry conditions. It is much easier to accurately measure volumes of dry sand than damp or wet sand. This is because most sands swell and increase in volume when damp or wet so if damp sand has to be used this 'bulking' must be taken into account and a greater volume of damp sand will be needed for each volume of lime.

Useful sands for work in South Somerset are Chardstock and Warmwell sands available from the suppliers listed later. Most builders merchants sell sand of unspecified origin and it is only by looking at it and feeling it that you will be able to assess whether it is suitable for lime mortar.

Crushed limestone dust is sometimes used as aggregate. Particles of limestone are more porous than sand grains and can help entrain air into the body of the mix aiding carbonation and producing good, durable mortars. But, although stonedust was often used traditionally, it can be very difficult to use successfully. It is often supplied nowadays as a very fine powder which requires the addition of a great deal of water to make a workable mix and makes the mortar more prone to shrinking and cracking. If stone dust is added it should be crushed and sieved to produce a well graded aggregate. Since most users do not have access to a set of standard mesh sieves, and since most suppliers would charge a small fortune to sieve stone dust for you, it is probably better for DIY users to avoid using it, or at least to use it in small quantities of say no more than $^1/_2$ part stone dust to $2^1/_2$ parts of sand.

Occasionally other materials, such as crushed shells, kiln slag and ash were used as aggregate in traditional mortars, and these will often be evident when looking at the old mortar. However they are rarely used nowadays except for very specialised conservation work.

ADDITIVES

Historic mortars often contain a variety of substances such as milk, blood, linseed oil and tallow, which were added to alter the mortar's properties. However the benefit of some of these additives is questionable and nowadays such additives are only used in exceptional circumstances and following detailed analysis of their effects.

Many modern mortar additives are on the market but most of these are either unnecessary or unsuitable for use with lime mortar. Plasticisers are not needed as lime mortar is naturally extremely workable. Accelerators or antifreeze additives can introduce harmful soluble salts into historic masonry and should not be used in mortar for historic work. If lime mortar must be used during periods of frost-risk the work should be protected from freezing until it has carbonated. Waterproofers are also unsuitable for lime mortars as they reduce the ability of the mortar to breathe and thus reduce one of the greatest advantages of using lime mortar.

Certain materials, known as pozzolanic additives, may be added to lime mortar to increase its initial set and also to increase its durability in exposed locations. The most commonly used pozzolans are brick dust made by crushing and sieving soft, under-burnt bricks, volcanic ash called trass and calcined china clay sold under the name of Polestar or Metastar (see list of suppliers at end of booklet). Lime mortars are frequently gauged with ordinary Portland cement or white cement to speed up the initial set. However recent research has suggested that the addition of small quantities of cement may actually weaken the mortar and it is better to avoid the use of cement in lime mortars.

Although pozzolanic additives can be extremely helpful their use is usually best restricted to the more specialised conservation projects. In many circumstances a simple lime mortar will perform perfectly well and be remarkably durable provided it is properly mixed and applied and allowed to dry out slowly and carbonate properly.

Animal hair is traditionally added to lime plasters and renders to reinforce the mortar and reduce shrinkage cracking. It is particularly valuable in strengthening plaster applied to wooden laths but is also frequently found in plasters on a masonry backing. It should be supplied washed and sterilised.

READY- MIXED MORTARS

A number of specialist suppliers can now provide ready-mixed lime mortars. These are usually sold in bags or plastic tubs which can be stored indefinitely if protected from frost,. Provided they have matured for long enough (at least one month) they require only tipping out and knocking up before use. Each supplier will have a selection of standard mortars for different purposes such as pointing, plastering or rendering, but special mixes using a particular sand or incorporating hair can usually be made on request and at extra cost. Mixing your own lime mortar is time consuming and hard work so ready-mixed mortars, which are tried and tested, are ideal. Suppliers will also usually give advice about using the materials.

MIXES & PROPORTIONS

When using lime mortar to repoint or re-render an old building care should be taken to ensure that the mortar used is as close a match as possible to the original in terms of colour, texture and composition. The original pointing mortar can often be revealed in the joints behind newer pointing or render, but it must not be confused with mortar used for a previous repointing or with the mortar used for bedding the masonry. Some lime mortar suppliers have facilities for analysing the constituents of old mortars so that they can be accurately matched, but in most cases mortars can be matched by eye and by making up a few trial mixes. Where it appears that the original mortar contained a high proportion of fine material and that a replica mix may perform poorly then it might be better to use a better graded aggregate rather than to repeat a mistake for the sake of historical accuracy.

Where there is no evidence of the original mortar an appropriate new mix can be made taking into account the type and hardness of the building material and the exposure of the building. In general, soft, porous or severely weathered stone must be treated with a softer, weaker mortar than hard, dense stone.

For pointing and rendering there is the choice between using hydraulic or non-hydraulic lime (with or without a pozzolanic additive) for the binder. The decision usually depends on the nature of the wall being treated and its degree of exposure. However, this is a subject about which there are strong and varied opinions. English Heritage is undertaking research which it is hoped will sort out some of the controversy, but at the moment it is almost impossible to give hard and

fast guidance about which lime should be used in which circumstances. There is general consensus that a hydraulic mix is suitable for use below ground level or in areas subject to prolonged periods of dampness, and that rendering on cob walls and internal plastering should be undertaken using non-hydraulic mixes, but beyond this there is little agreement amongst practitioners. However, for most stone and brick in reasonable condition there is, technically, little to choose between a hydraulic and a non-hydraulic lime and the decision often rests with the personal preference of the person applying it or the architect specifying it. Non-hydraulic lime is very sticky and nice to use, although it is more likely to suffer shrinkage. A non-hydraulic mortar can be given a hydraulic set by adding a pozzolan, but incorporating the pozzolan evenly can be hard work, especially for large volumes of mortar, and it is more expensive than using a hydraulic lime. Hydraulic lime tends to be leaner, or less sticky, and so can be more difficult to use, but tends to set faster and shrink less. Because it can be mixed more easily (see later section) it can work out cheaper to mix your own hydraulic lime mortar in a drum mixer than to buy ready mixed non-hydraulic mortar. In more exposed locations science tends to suggest that hydraulic limes would perform better but there are plenty of practitioners who can point out ancient non-hydraulic lime renders on west facing church towers which are still going strong. The debate is likely to continue for some time.

The most basic lime mortar mix consists of 1 part of lime to $2^1/_2$ or 3 parts of sand. In these proportions there is just sufficient lime to thoroughly coat the sand grains and fill the voids between the grains forming a compact cohesive mortar. By varying the type of lime and sand used in such a mix an infinite variety of mortars can be created to suit the requirements for pointing and rendering.

It is not advisable to use a mixture of hydraulic and non-hydraulic lime in the same mix as the behaviour of such hybrid mixes is not properly understood. For a quicker initial set pozzolanic materials may be added to a basic non-hydraulic mix but further advice should be sought before using them as they may have an adverse effect in certain circumstances.

For repointing very finely jointed ashlar a more lime-rich mix is usually used. A mix of 1 part lime to 1 part fine sand is quite common and for the very finest of joints pure lime putty is used.

The following table gives examples of mortar mixes which might be suitable for certain applications.

MORTAR MIX	APPLICATIONS
1 pt non-hydraulic lime : 3 pts sand	Pointing weak masonry such as decayed Blue Lias or Hamstone, or soft brick Internal plastering External rendering in a sheltered location or on a very weak backing such as decayed stone or on cob Conservation repairs to stonework
1 pt non-hydraulic lime : 3 pts sand plus 10% pozzolanic material	Pointing weak masonry such as decayed Blue Lias or Hamstone, or soft brick in an exposed situation External rendering in a moderately exposed environment or on a weak backing such as decayed stone or on cob but in an exposed environment Conservation repairs to stonework in an exposed environment
1 pt feebly hydraulic lime (NHL2) : 2 $^{1}/_{2}$ pts sand	Pointing reasonably sound masonry, such as sound Blue Lias or Hamstone in sheltered to moderately exposed environment
1 pt feebly hydraulic lime (NHL2): 2 pts sand	External rendering on reasonably sound masonry in sheltered to moderately exposed environment
1 pt moderately hydraulic lime (NHL3.5): 2 $^{1}/_{2}$ pts sand	Pointing sound masonry, such as sound Blue Lias or Hamstone in a moderate to exposed environment New building
1 pt moderately hydraulic lime (NHL3.5): 2 pts sand	External rendering on sound masonry in a moderate to exposed environment
1 pt eminently hydraulic lime (NHL5): 2 $^{1}/_{2}$ pts sand	Pointing sound masonry in conditions of severe exposure, including copings, plinths and high level work For building and pointing in wet environments such as bridges, mill races and work below ground level
1 pt eminently hydraulic lime (NHL5): 2 pts sand	Rendering sound masonry in conditions of severe exposure Rendering in wet environments such as below water and below ground level

MIXING MORTAR

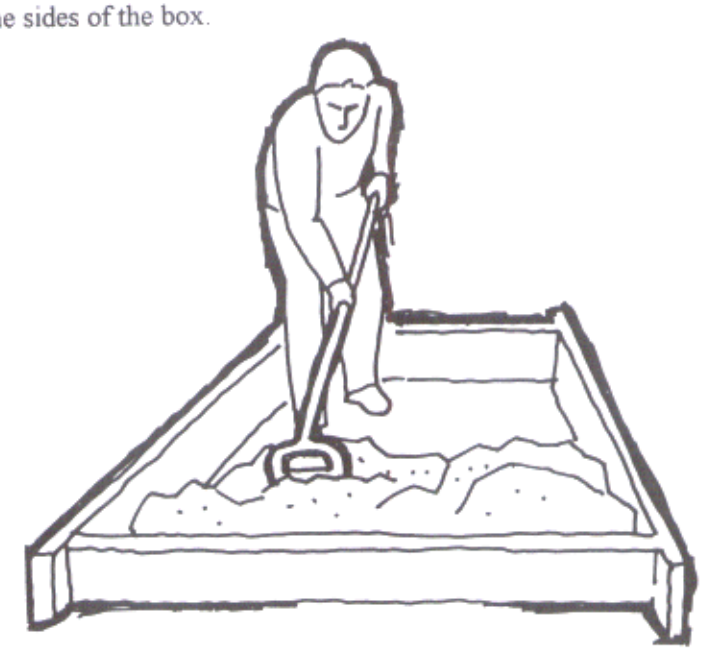
MIXING NON-HYDRAULIC LIME

It is vital that lime mortar is thoroughly mixed before use to ensure that the lime is well distributed and that any lumps are broken down. Good mixing is also needed to make the mortar more workable. Mature lime putty is initially stiff with a dry, cheesy consistency. It is rather hard to mix sand into this stiff mass and there is often a temptation to add water to help in mixing. However, with persistent chopping and beating with a shovel, or working with a paint stirrer attached to a drill, the lime becomes much more liquid, resembling cream cheese or toothpaste, and the sand can be worked into it without the need for extra water.

Commercially made mortars are mixed in a mortar mill. This consists of a wide pan with two revolving rollers, which crush and squeeze the mortar ingredients together. The pressures involved ensure an intimate contact between the sand and the lime as well as eliminating lumps.

The revolving drum type of cement mixer is not ideal for mixing lime mortar. As there is no pressure applied to the ingredients the lime tends to remain lumpy and usually just sticks to the sides of the mixer without mixing with the sand. The temptation is to add more water but mortar made this way is too liquid and prone to shrinkage as the water evaporates. If tipped out and stored in stout wooden boxes (solid wood, not plywood) or a timber-lined lime pit, the water can seep away leaving a usable mix, but making the wooden boxes or pit is time consuming and expensive, and only worthwhile if you have a lot of mortar to mix and cannot stand the thought of hand mixing. Alternatively put some bricks or stones into the drum whilst it is mixing, to help beat and compress the ingredients, and scrape the sides of the drum occasionally. A reasonable mix can be made this way after about 25 to 30 minutes mixing.

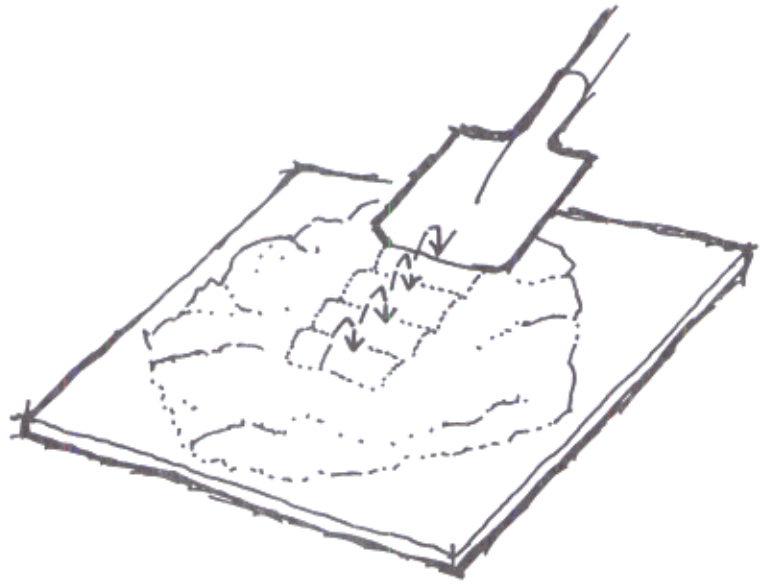
Traditionally mortars were hand mixed in a large, shallow wooden box using a hoe-shaped tool known as a larry. The mortar could be thoroughly mixed by turning it with the larry and by pressing it against the sides of the box.



Unless you have access to a larry and a box you will have to mix your mortar using a shovel as follows.

• Accurately measure the quantities of sand and mature lime putty using gauging boxes or, more commonly, plastic buckets, and tip the ingredients onto a clean wooden mixing board.

• Using a clean shovel chop and press the mixture with the back of the shovel using as much downward pressure as possible and working across the heap from the far side back towards your feet. A dirty shovel with dried-on lumps of mortar will make mixing even harder work than normal as the lime will stick to the shovel.



• Turn the mix over with the shovel and repeat the chopping and pressing until the sand and lime are well mixed and the consistency is soft and workable. This may take up to twenty minutes. It is unlikely that any water will need to be added. In most cases the water present in the lime putty is sufficient. When properly mixed, a blob of mortar dropped from a height of a few inches onto a hawk will stick to the hawk when it is turned upside down.

• You will now have a basic mortar known as coarse stuff. Although it can be used immediately it improves if stored in airtight containers protected from frost for at least one month. When you come to use it you will probably find that it has stiffened up and become crumbly. Tip it out onto a clean wooden board and mix it with a shovel, as described above, to restore its plasticity. This is called 'knocking up'. No additional water should be added.

If you buy ready mixed mortar you will simply have to tip the mortar onto the mixing board and knock it up ready for use. This is much easier than mixing your own mortar and for most people the extra cost of buying mortar is more than offset by the savings in time and effort.

MIXING HYDRAULIC LIME

Making mortar using hydraulic lime in powdered form is easier than using lime putty as the sand and lime can be hand mixed together dry before the water is added, in the same way that cement mortar is mixed. Alternatively, it can be successfully mixed in a drum mixer. However, you must be careful to avoid adding too much water. The mortar will become wetter and more plastic as mixing continues. About twenty minutes in a drum mixer should be sufficient. The finished mix should be reasonably firm, not sloppy. Leave for about twenty minutes to allow the lime to swell or 'fatten up', to improve its workability, then mix again briefly using a shovel, paint stirrer or in the drum mixer immediately before using.

Hydraulic lime mortars should be used within a few hours of mixing (sometimes as little as two hours). Refer to the manufacturer for maximum time allowed. Once a hydraulic mortar starts to stiffen it should not be knocked up as this will reduce its hydraulic properties. For this reason mix only as much mortar as you will use within a few hours.

Some practitioners advocate leaving the mix to fatten up overnight and knocking it up for use the next day. Whilst this will create a fatter, more workable mix, it will almost certainly reduce some of the hydraulic set and therefore reduce the advantage of using a hydraulic mix. However, advocates of this method vehemently deny any reduction in the performance of such mortars. It is probably best to take the advice of the manufacturer regarding knocking up. In the past hydraulic mixes were often made by layering hydraulic quicklime with sand, sprinkling it with water and leaving it overnight for the lime to slake. During slaking the lime expands and crumbles, mixing with the sand, reducing the amount of hand mixing needed. It is possibly this procedure which initially gave rise to the practice of leaving a hydraulic mix overnight.

If you use freshly slaked hydraulic lime putty the techniques for mixing are the same as for non-hydraulic lime putty, except that the mixture cannot be stored - it must be used within a few hours of mixing.

RE-POINTING

WHEN TO RE-POINT

Pointing is vital in keeping a masonry wall weather-tight and if done badly the results can be disastrous both technically and visually. Pointing is intended to be sacrificial so that it decays in preference to the stone or brick. It therefore needs replacing from time to time. It is quite common to find that only some of the joints in a wall have decayed and in such cases only these joints should be re-pointed. If the mortar is carefully matched the patching will quickly weather to match the rest and of course it is cheaper to re-point only those joints that need it rather than a whole wall. A great deal of money is wasted on unnecessary re-pointing, reducing the amount of money available for other repairs.

Traditional lime mortars are usually soft and, although they can often be scratched with a finger nail, they can still perform their function of keeping the inside of the wall dry. Re-pointing is only necessary when the mortar has become so loose, powdery, decayed or eroded that water can penetrate the joints. Do not mistake soft lime mortar for decayed mortar. In most cases if much effort is required to scrape out the mortar then the wall does not need re-pointing.

If a wall has been re-pointed with cement mortar which is still in good condition it will probably be very difficult to remove. Removing it may damage the stone so unless there is a significant problem of damp penetration it may well be best to leave it until it cracks of its own accord (which it almost certainly will). Once it has cracked away from the face of the stone it can then be picked off quite easily. Unfortunately by this time the stone may have been damaged by the mortar but probably no more than would have occurred by trying to remove the mortar whilst it stuck firmly to the stone.

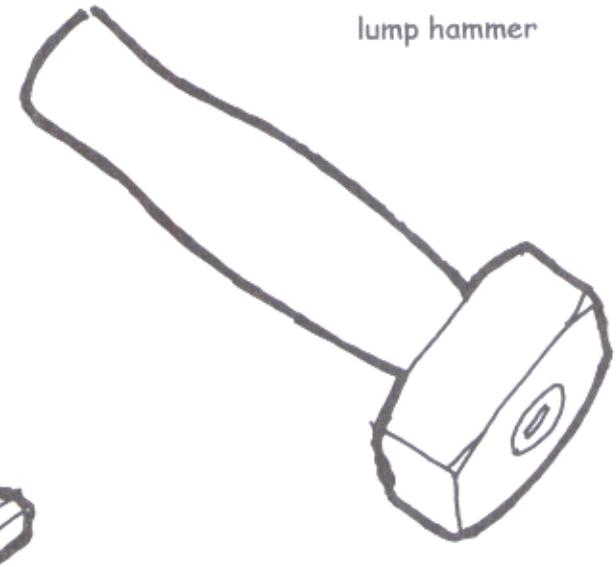
PREPARING THE WALL FOR RE-POINTING

Although lime mortar seems sticky when being used it will not stick well to smooth surfaces as it dries out and so it requires a good key (or roughening of the surface) to help to hold it in place. Thorough preparation of the surface is essential to create a good mechanical key.

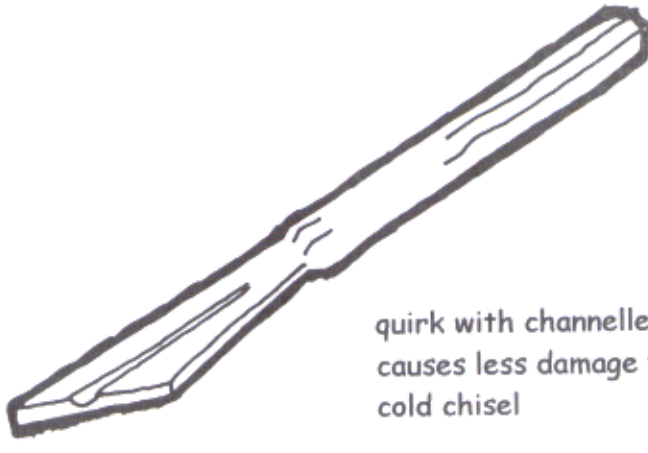
- Rake out all loose, powdery or decayed mortar until sound mortar is reached, but in any case to a depth of at least the width of the joint, preferably one and a half times the joint width. Sometimes, especially in the case of rubble walls which have been repointed in cement mortar, there may be large voids behind the pointing where bedding and core material have settled or been washed down and it will be impossible to reach sound mortar. Ideally such walls should be grouted to restore some strength and solidity, but alternatively the voids may be filled and tamped as described later. Use hand tools for raking out, preferably scraping and picking rather than hacking or chiselling. A hoof pick or bent spike is often handy for this. If harder mortar has to be chiselled out use a quirk which is specially shaped to channel the mortar chippings out of the joint. A cold chisel will tend to wedge in the joint spalling the arrisses as it removes the mortar.

Try to remove a bit at a time rather than digging in deeply. Some contractors recommend the use of power cutting tools but, in all but the most skilled hands, irreversible damage to the edges of the stone is almost inevitable and such techniques should be avoided. Very fine joints should be cleaned out using a hacksaw blade. On no account should you widen the joints to make pointing easier.

hoof pick or bent metal spike - useful for scraping out old soft mortar



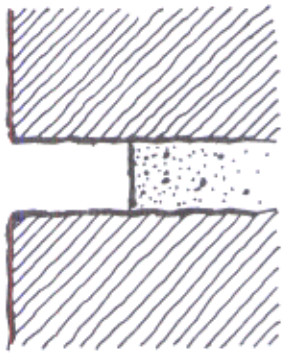
lump hammer



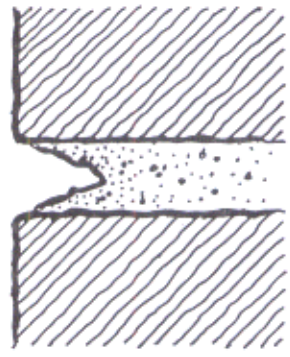
quirk with channelled blade - causes less damage than a cold chisel

hacksaw blade for cleaning out fine joints

• Be sure to clean the mortar off the top and bottom of the joints leaving a clean square joint, avoiding a V shape. It is vital that the joints are properly cleaned out or the new pointing will not last well and money will have been wasted.



A clean square joint creates a good key for new mortar



A v-shaped joint provides a poor key for repointing

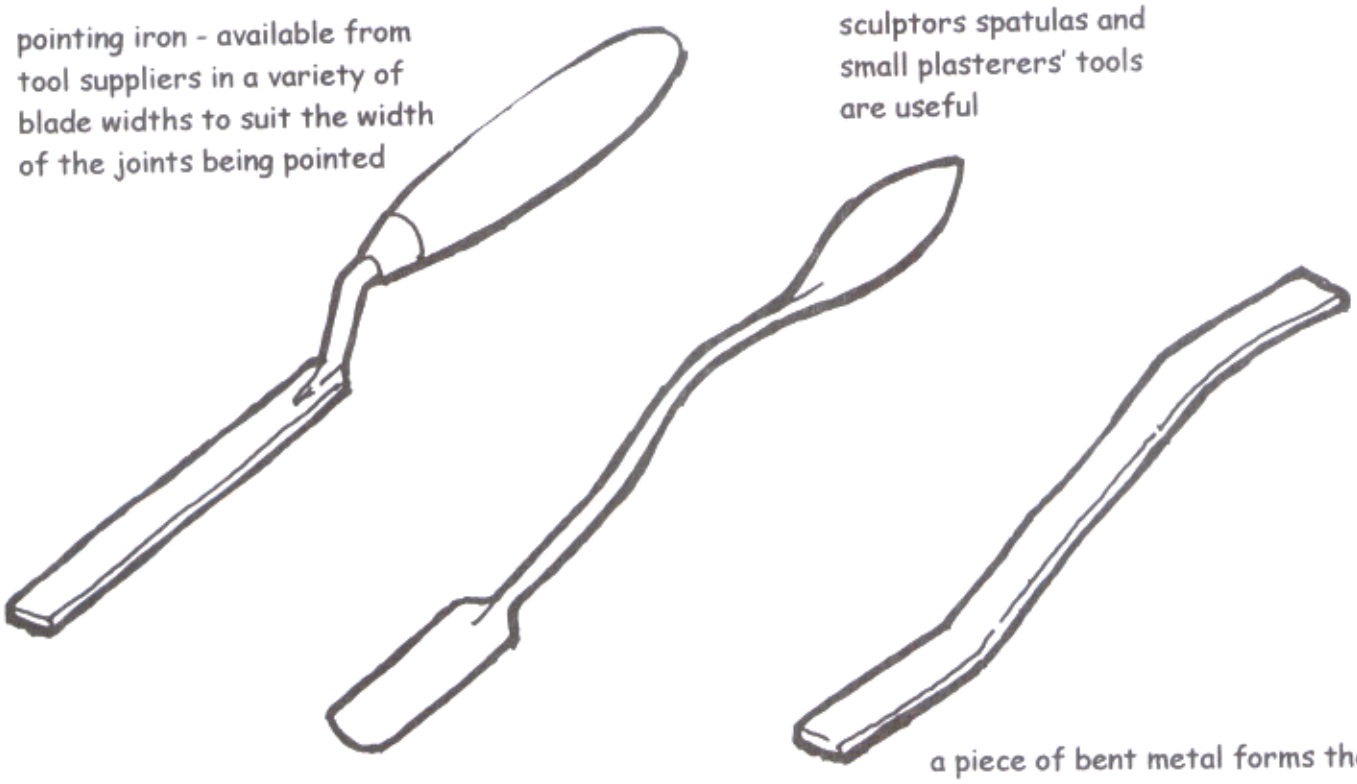
• Brush loose material out of the joint. Dust can be removed by blowing down a length of tubing such as hosepipe (wear goggles to prevent dust in your eyes) which helps to avoid a slurry of old mortar getting onto the face of the masonry when it is sprayed . Spray with water to dampen the wall. The masonry must be damp before the mortar is placed, otherwise it will draw the water out of the mortar before it has started to set. Spray again a few minutes before pointing so that the joints are visibly damp, but without water standing on the surface of the stone. It is surprising how much water the masonry can absorb, especially very porous stone or bricks.

RE-POINTING

A few simple tools are required for re-pointing. You will need a water sprayer or hose pipe for dampening the wall, a hawk to hold the mortar whilst you work and pointing irons or trowels that fit into the width of the joint to be pointed so the mortar can be pressed in firmly. Ordinary pointing trowels are seldom satisfactory as they do not fit into the joint, although they can be cut or ground down to size. Using the wrong tools makes the work surprisingly difficult and invariably results in a messy finish and less durable pointing. For finishing off you will need a short length of timber batten and a stiff bristle brush, such as a churn brush, or a piece of hessian.

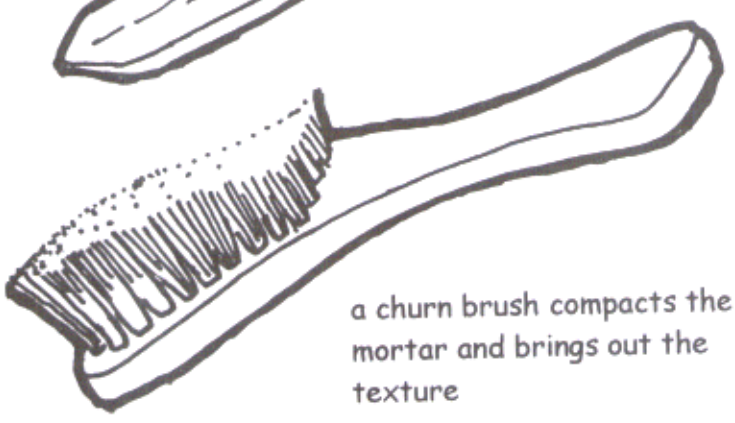
pointing iron - available from tool suppliers in a variety of blade widths to suit the width of the joints being pointed

sculptors spatulas and small plasterers' tools are useful

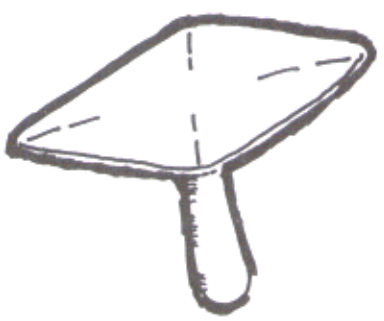


a piece of bent metal forms the simplest pointing tool

a piece of wooden batten - useful for consolidating mortar as it hardens



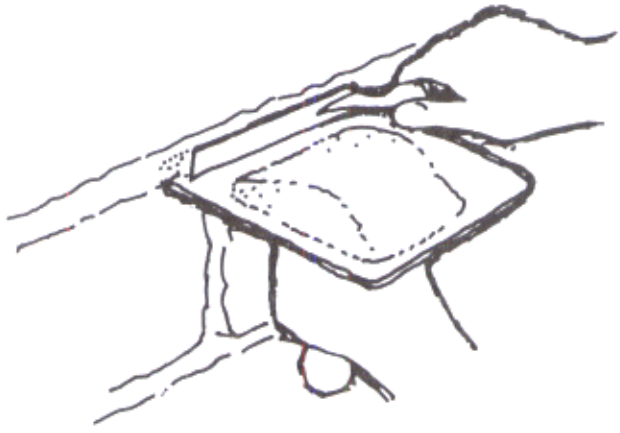
a churn brush compacts the mortar and brings out the texture

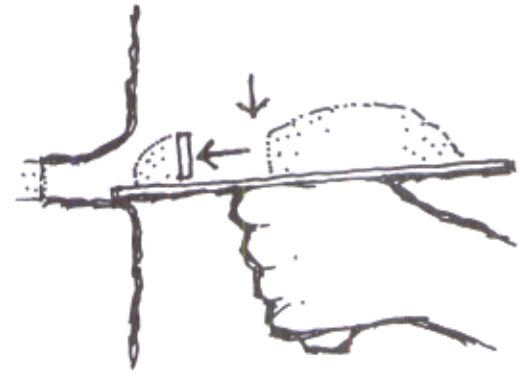


a small decorators hawk is easier to use than a large one

• Knock up the mortar immediately prior to use to ensure that it is workable. It should be sticky but not too sloppy and, when dolloped onto a hawk or trowel, should stick even when turned upside down.

• Scoop some mortar onto the hawk and hold it close to the wall. Using the pointing iron cut off a thin wedge of mortar from the side of the hawk closest to the wall and push it into the joint. Press firmly to compact the mortar. If you are right handed you should work along the joint from right to left so that each wedge of mortar is packed down onto the previous one. Be sure to push the mortar right to the back of the joint so there is no gap behind the new pointing.





• Lime mortar should be built up in thicknesses of no more than an inch to allow air to penetrate and initiate the hardening process. If the joints are deeper than this use a hydraulic lime or a pozzolanic additive for deep filling and point up the last inch in the ordinary mix. Alternatively place the first inch and wait for several days to allow it to start carbonating before dampening with the spray and placing another inch, and so on, until the joint is filled.

• If some of the joints are very deep, partly fill the back of the joint with mortar and press some small pieces of stone or tile into the mortar, tapping them in firmly, and wait for this to start to harden before filling the rest of the joint in one inch layers. For large voids it is impractical to fill in one-inch layers which means that the mortar is unlikely to completely carbonate, or will do so only very, very slowly. This is not necessarily a problem because the wall will still be stronger and more solid than it was before you started, but for maximum strength the mortar should be gauged with a pozzolan or a hydraulic lime mortar can be used. Deep filling, especially of voids uses a lot of mortar and you should take account of this when estimating the amount of mortar you will need.

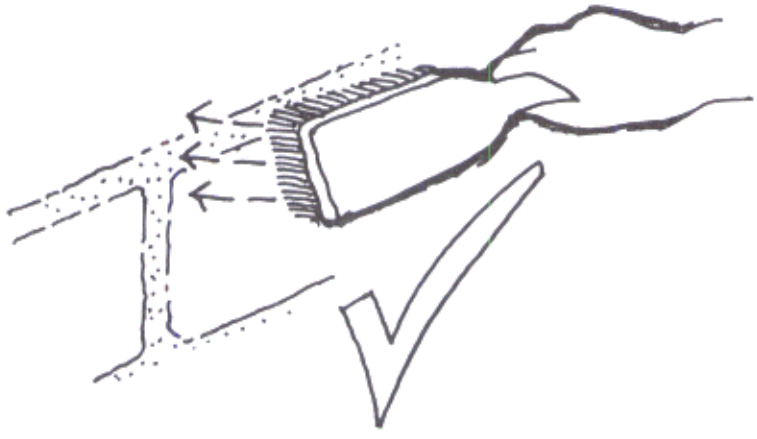
• Do all the deep filling first until all the joints are just an inch deep, then do the final pointing of the whole area in one go to achieve a uniform finish.

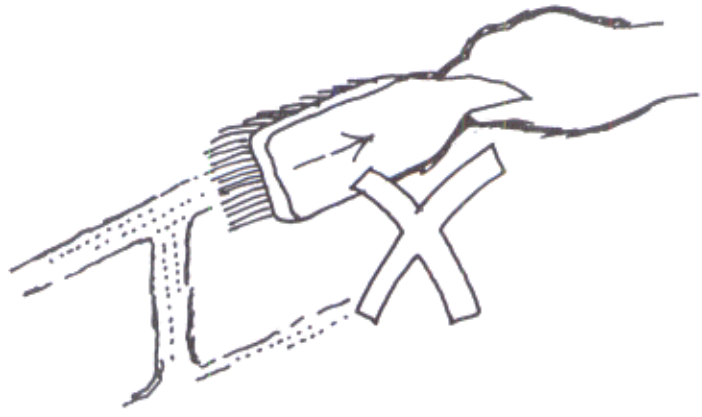
• Slightly over-fill the joint. Do not try to smooth the surface with the trowel, just push the mortar into the joint and leave it rough for the time being. Sponge off any mortar that accidentally gets onto the face of the stone using clean water.

• Leave the mortar until it starts to harden. It is important that the mortar is allowed to dry out very slowly so that setting and carbonation can occur. If it dries out before the chemical reactions have occurred it will be crumbly and friable and soon fail. The speed of set slows down as temperatures fall, and for hydraulic limes it is negligible below 5^0C. If you are lucky enough to have mild, calm, slightly damp conditions whilst re-pointing, the mortar will probably need little attention as it firms up. But if it is sunny or slightly windy you will need to tend the work and keep it damp either by lightly spraying it (don't use a hose pipe unless fitted with a spray nozzle - it is too vigorous) or by flicking water onto it from a brush. If the mortar starts to turn very pale, almost white, then it is drying out too quickly, and lime is being drawn to the surface as water evaporates. If you are unable to tend the work, say at the end of the working day for example, then it must be protected from direct sunshine, drying winds and rain using damp hessian and/or polythene sheeting. For small patches simply tack the polythene or hessian into position using roofing felt nails tapped into the mortar joints surrounding the patch. For a larger area such as a whole wall it is best to wrap the sheeting around a length of wooden batten and nail through this into the wall above the treated area or into the wooden wall plate at the top of the wall. The bottom of the sheet can then be held down with stones. It should be held clear of the wall so that air can circulate.

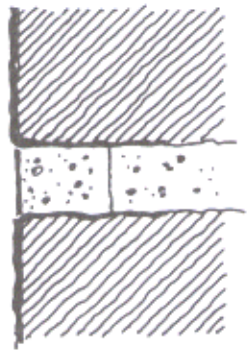
The importance of slow drying cannot be over-emphasised, and applies to both hydraulic and non-hydraulic lime. Work which dries out too quickly cannot be successfully re-vitalised later by wetting and will simply have to be re-done.

• The mortar is ready for finishing when it still looks damp but has hardened up so that a finger pressed onto the surface barely leaves any impression. A piece of timber batten or stick with a rounded end cut to the width of the joint can be used to press the mortar back into the joint and to rub it back very slightly to reveal the edges of the stone and bring out the texture. The joint can be further consolidated using a stiff bristle brush to beat the surface of the mortar. Avoid brushing along the joint as this can leave brush marks and can smear mortar over the face of the stone. A piece of hessian can also be used to push the mortar in and raise the texture. The purpose of this stage is to close up any cracks that might have formed as the mortar dries out and to ensure that the mortar is firmly pressed back into the joint. It also helps to remove feather edges and reveal the shape of the stone and brings out the texture of the mortar.

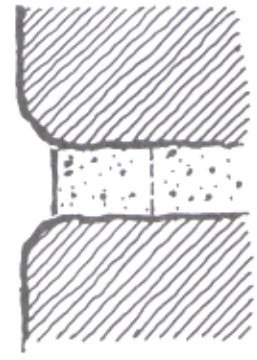




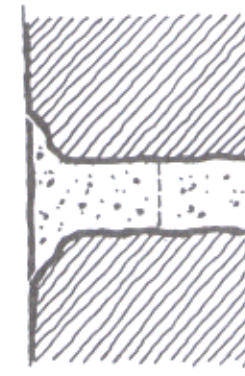
It is in this stage that the most skill is required to avoid creating an uneven, wavy surface to the joint. It is best to aim for a flat, vertical face to the joint, very slightly recessed behind the face of the stone and no wider than the original joint width. On squared stonework with weathered or spalled arrisses avoid the temptation to bring the mortar forward to the edge of the stone as the finished joint will then appear much wider than the original.



New mortar finished flush with the face of the stone



New mortar set back from the face of the stone where the stone is weathered maintains the original joint width



Mortar brought flush with the face of weathered stone increases the apparent joint width

This method of pointing and finishing the joints works well for many types of stone and brickwork encountered in vernacular buildings. Buildings made of very rough, poor quality rubble stone with wide and irregular joints, were probably originally protected with a lime render. In such cases it is usually more successful either to re-render or to bring the pointing out flush with the stone surface, even completely covering some of the smaller stones, in a sort of semi-render, and then to limewash the wall, rather than attempt the style of pointing described above. Also, if there is evidence that the original style of pointing was particularly distinctive or if the joints in the stonework are very fine a different technique may be required and further advice should be sought.

• Lightly spray the pointing using a fine spray. The wall will need frequent spraying as the mortar hardens and in sunny or windy conditions it will need protecting with hessian and/or polythene to prevent rapid drying. Both hydraulic and non-hydraulic limes must be kept slightly damp whilst they carbonate but at the same time air must be allowed to circulate. If using polythene or tarpaulin it should be fixed so that there is a gap between it and the wall. You will need to keep an eye on new work for at lest a week and dampen it down and protect it if it starts to dry out too quickly. Frost can cause damage to new pointing if temperatures drop below freezing whilst the mortar is still quite wet. It is best to avoid re-pointing if frost is likely.

RENDERING AND PLASTERING

LIME RENDER & PLASTER

Lime renders were traditionally applied to give protection to walls built of poor quality rubble stone or porous brick or to walls in exposed locations facing driving winds. They help by acting like a sponge, absorbing rainfall then allowing it to evaporate rather than soak into the wall. Most cottages and houses built of rubble stone would have been rendered originally and they tend to suffer from penetrating damp if the lime render is removed or replaced with a cement rich render.

There is a very wide range of types of lime rendering. Rubble walls of many vernacular buildings were often treated with just a single coat of render, or even a scratch coat amounting to not much more than a very full, flush pointing. Such a render is thicker in the hollows and very thin over the stone faces. There was no attempt to create a flat surface so the undulations of the wall and even some of the stones themselves were not concealed. For a smarter finish or on more prestigious buildings the aim would be for a more uniform render achieved by applying a scratch coat to fill the hollows and take up some of the unevenness followed by one or two more coats which were worked to a flatter surface. Sometimes joint lines were ruled into the damp top coat to create the illusion of ashlar stone, but a common finish for many houses and cottages was a rough-cast where the final coat consisted of a mortar slurry containing coarse grit applied by throwing from a special trowel. For interiors a fairly smooth surface could be obtained using a coarse render mix, but for top quality internal plastering the final coat would be richer in lime and polished up to a smooth, close finish.

Renders and plasters can be applied to a variety of backgrounds including cob (which should nearly always be rendered), stone and brick. Plaster is also applied to wooden laths for ceilings and internal partitions.

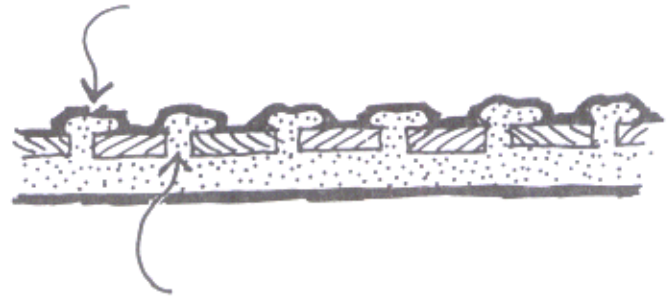
By carefully selecting appropriate aggregates it is possible to match existing renders and successfully repair failed patches without the need for complete re-rendering. Hollow or detached plaster can sometimes be consolidated and saved and further advice should be sought before replacing it, especially if it is very old.

PREPARING THE WALL

• For stone and brick any hollow or decayed render should be hacked off and any loose pointing should be raked out and replaced prior to rendering. Brush the wall to remove loose material. Do not rake out pointing to provide a key. Do not use plastering bead on corners as this will give a modern appearance. Do not use chicken wire or metal lath to form a key as it can cause stress in the render due to differential thermal movements and can lead to large-scale failure, especially when it rusts.

• For plastering onto existing wooden laths check that they are firmly fixed and free of lumps of old plaster. New laths should ideally be riven oak or chestnut. Sawn laths are inferior as they are smoother and weaker than those split along the natural grain of the wood. Laths should be fixed so that the distance between them is roughly equal to their thickness. So, laths that are 3mm thick should be spaced 3mm apart. This allows the right amount of space for the plaster to be pushed between the laths and flop over to form a key. Do not apply preservative treatments to either old or new laths as they can introduce harmful salts into the plasterwork. Metal lath is sometimes used internally instead of timber laths as it is quicker to fix and cheaper, but it is harder to plaster onto as it is slippery and the sharp edges may cut into and weaken the plaster key. Plenty of hair in the mix is essential.

plaster pushed between laths form a key



space between laths equal to thickness of laths

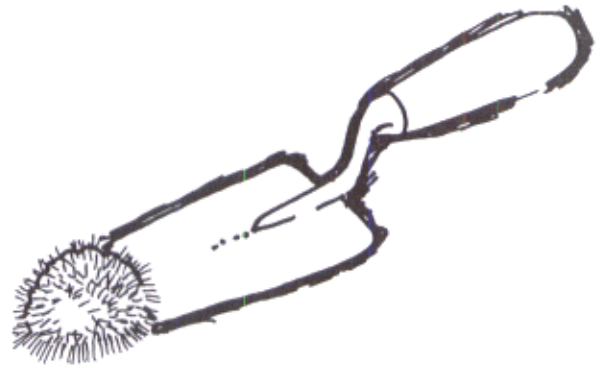
• For masonry, thoroughly wet the wall with clean water using a hose-pipe or sprayer. The more porous the background the more water will be required. Allow the water to soak in a bit then spray again, and repeat until the surface layers of the wall are thoroughly damp. When the render is applied the wall should be damp but without water glistening on the surface. Timber laths should be thoroughly dampened before plastering.

MIXING PLASTER AND RENDER

A basic lime render or plaster can be made using the same ingredients and mixed in the same way as a pointing mortar. A coarse sand can still give a smooth finish suitable for most vernacular buildings although the mix should be slightly richer in lime than a standard pointing mix, say one part of lime to two or two-and-a-half parts of sand. Do not be tempted to use a soft, fine sand - you will just end up with lot of cracks. The mix will need to be slightly wetter than for pointing but it should be slightly stiffer than its modern cement or gypsum counterpart. Once you start plastering you will soon discover whether your mix is the right consistency: too thick and it will be virtually impossible to apply it smoothly and get it to stick to the wall; too thin and it will go on beautifully then slump, sag or drop off.

Whether you mix your own or buy ready mixed lime render or plaster it is a good idea to ensure that the lime putty used is at least three months old. This will ensure that the lime is thoroughly slaked. If the lime is younger than this any unslaked particles in the mix may slake some time after plastering causing a small eruption or 'lime blow'. Most suppliers do not stock putty older than three months as standard, but if you are able to buy some and keep it yourself for a few months before use, so much the better. Many practitioners advocate the use of six month old putty for plastering, but few suppliers stock it.

When plastering onto lath it is essential to add hair to the mix to help in forming a key of plaster between the laths. Whilst it is not essential to use a haired mix for other backgrounds it can help to reduce shrinkage. Goat and cattle hair are preferable to horse hair which is too slippery. Hair should be added to the mix just before use. Do not add hair to coarse stuff that is to be stored for more than about six weeks as the hair may rot if left in damp lime mortar for a long time. The hair should be gradually teased into the mix so that it is well distributed and does not form clumps (often referred to as 'dead mice'). As a rule add one pound of hair per three cubic feet of mortar for walls and one pound of hair to two cubic feet of mortar for ceilings. For the second coat halve the quantity of hair. To check whether there is sufficient hair in the mix, scoop a dollop of mix into a gauging trowel, tap the underside of the trowel smartly against a hard edge so that the blob flattens and the surplus mortar falls off the edge of the trowel. There should be a fringe of hair at 1-2mm intervals around the edge of the trowel.



APPLYING RENDER

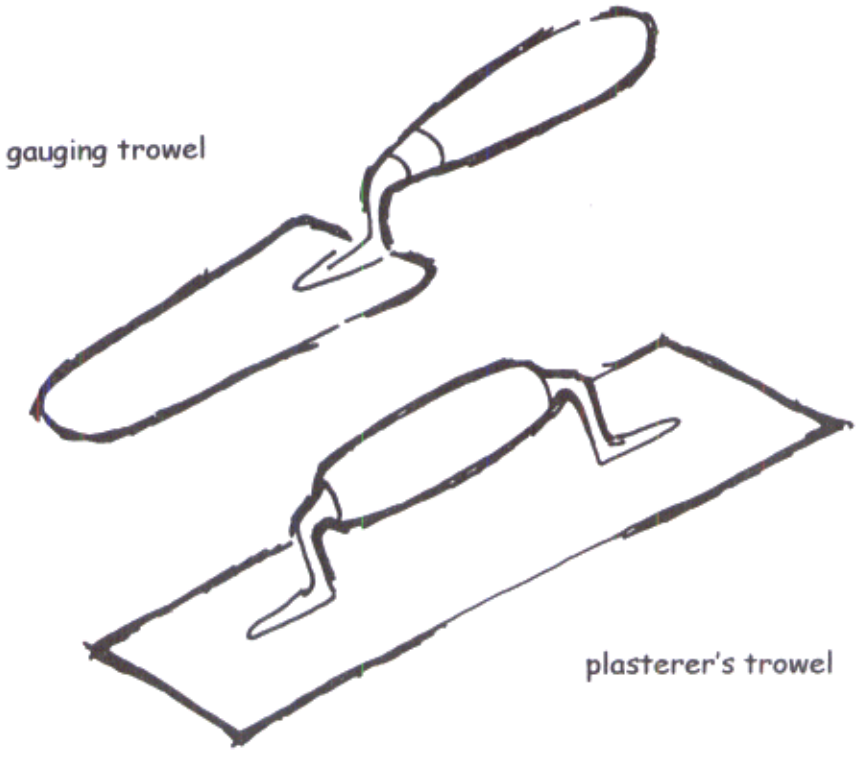
There are many different ways to apply render depending on the type of finish required, the type of lime used and the preference and experience of the person applying it. The following should give you an idea of some of the common procedures but is by no means the final word.

Rendering or plastering is not something that can be easily taught without a practical demonstration, but if you have already done some plastering or can get someone to show you how, there are several guidelines that will help you to use lime render successfully.

• Lime renders shrink as the water in them evaporates. This can be minimised by using a well graded aggregate, by ensuring that the wall is well wetted before you start and by applying the render in thin coats of no more than half an inch. It also helps if the mix is as dry as possible but obviously it has to be wet enough to be workable and if you observe the other points you can get away with a slightly wetter mix which is easier to use.

• If there are deep hollows in the surface of the wall dub them out first using lime mortar and small bits of stone or tile, and allow this to firm up before applying the first coat of render. There is no need to try to create an absolutely smooth flat surface as on most old buildings lime render and plaster looks best if it follows the contours of the wall.

• Lime renders must be applied using as much pressure as possible to force the mortar into the surface crevices or between the laths to form a close contact between mortar and backing. For masonry walls, whilst it is possible to apply render using either a gauging trowel or a plasterers trowel the best result is achieved by throwing the mortar on from a trowel. This technique ensures the best bond between the mortar and the wall, expels any air in the mix and ensures that the mortar is well compacted. If you use a float or gauging trowel it is very difficult to apply the render with equal pressure all over the wall: it will tend to be under more pressure over the high spots and under less pressure in hollows and therefore more likely to drop off. Throwing render sounds difficult but it is surprisingly easy particularly for the scratch coat or dubbing-out coat, and involves less physical effort than using a trowel. This is particularly important if you are not used to plastering on a regular basis. It doesn't matter if the first coat goes on rather unevenly as you can remove any excess mortar by running the edge of a trowel over the surface to cut off the rough bits. Just remember to protect windows, rainwater goods and any other areas that you do not want covered with lime mortar, including yourself, particularly your eyes. If you prefer to trowel the mix on you may find it easier to apply the mortar using a gauging trowel rather than a plasterers trowel as it is better for getting into the hollows and maintaining an even pressure over the entire wall.



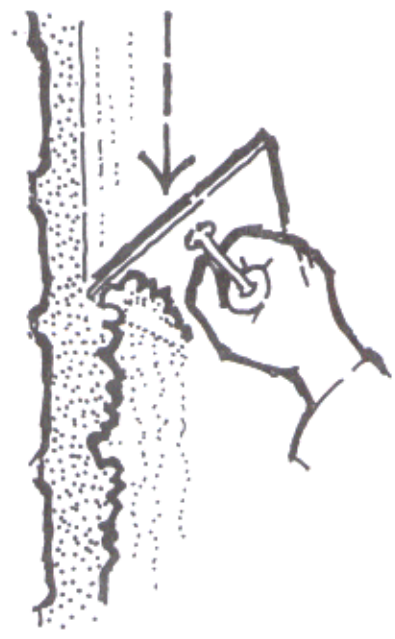
Once you have applied the scratch coat and got a fairly flat surface, subsequent coats can be applied successfully using a trowel, although it is still easier to throw it on.

Tyrolean rendering machines which splatter mortar onto the wall do not achieve the necessary level of compaction of the mortar as it hits the wall and are not suitable for the application of traditional lime renders.

For plastering onto wooden laths a plasterers trowel is suitable, but you must apply the plaster with enough pressure to force the mix between the laths so that it can flop over behind the laths and form the key.

• Use a clean tarpaulin or sheet of polythene to protect the floor or ground along the foot of the wall. You will then be able to scoop up and re-use any mortar that doesn't stick to the wall first time. If you simply cannot get the mortar to stick try re-wetting the wall or experiment with a slightly wetter mix.

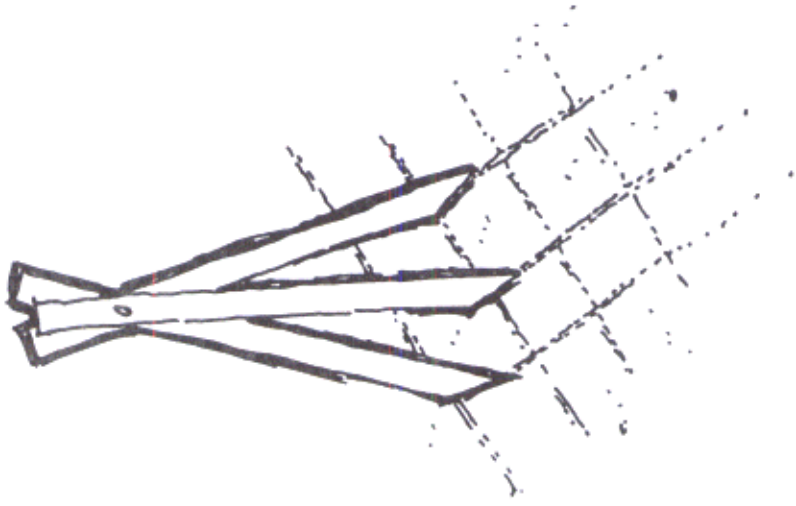
• As you apply the render do not try to smooth the surface by stroking with a steel trowel or float. Working the surface of the wet mortar with a steel tool will draw the lime to the surface creating a lime-rich layer over a weak, lime-depleted layer which can lead to premature failure of the render. Simply apply with one stroke, pushing hard or throw it on. If there are high spots or ridges hold the edge of the trowel or float against the wall and draw it across the surface. This will cut off the rough bits and leave a good open texture.



remove rough spots with the edge of a plasterer's trowel

• As the mortar starts to firm up it may develop cracks, although cracking will be minimised if the points in the first paragraph are observed, and hydraulic lime tends to suffer less from shrinkage and cracking. Cracks in the base coats can be left as they will not compromise the strength of the plaster and will be covered by subsequent coats. However, you must make sure that the cracks are due to shrinkage and not because the coat is peeling away from the backing; push the coat gently to check that it is firm against the backing.

• Create a key for the second coat by scoring the surface in a pattern of diamonds or wavy lines using a lath scratcher. Alternatively you can use a length of batten with nails hammered into but do not use the edge of a trowel as this will create too fine a groove to provide a good key. Some practitioners advocate throwing on the scratch coat and leaving it rough to provide the key for the next coat, but this depends on being able to throw the mortar on reasonably evenly in the first place or it will be almost impossible to render over it if there are huge humps and hollows. It is vital to take time and trouble over creating a good key as the adhesion of subsequent coats depends on it. Do not be tempted to miss areas in awkward places or at junctions with architraving or ceilings.



lath scratcher

batten with protruding nails

• There are two schools of thought regarding when to apply the second coat. Some practitioners advocate applying the second and subsequent coats whilst the previous coat is still 'green' or 'leather hard', that is after it has firmed up sufficiently to resist indentation with a thumb but is still soft enough to scratch with a finger nail and is still damp. In many cases this will mean the next day, but varies according to drying conditions. For internal plaster it may be anything up to a week or so between coats. This method requires less dampening of the surface before application of the second coat and may achieve a better bond between coats. However, there is a risk that there might be further shrinkage in the base coat after the second coat has been applied, and it will take a lot longer for the undercoats to fully carbonate and achieve full strength.

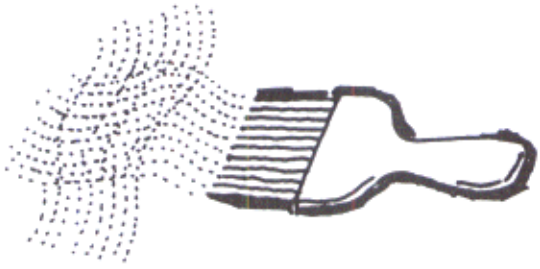
The alternative approach is to allow the base coat to dry out slowly and start to carbonate. The work should be protected from drying out too quickly by covering with damp hessian for at least one week, and often for two to three weeks according to conditions. By this stage carbonation will have started (but not be very far advanced) and there should be no further shrinkage in the base coat. The base coat needs to be thoroughly dampened down before applying the next coat. This method is more dependent on a good mechanical key between the coats, and requires a longer period for completion of the work than the first method.

• In the second coat cracks should be closed up by scouring the surface with a wood float using a circular movement and pushing hard to consolidate the coat. This will also enforce the bond between the coats and remove the high spots creating a flatter surface ready for the next coat. You may need to do this several times until the mortar is firm and no further cracks develop. The importance of this scouring and consolidation process for the success of lime rendering cannot be over emphasised. It must be done thoroughly no matter how wrist-breaking it may be.

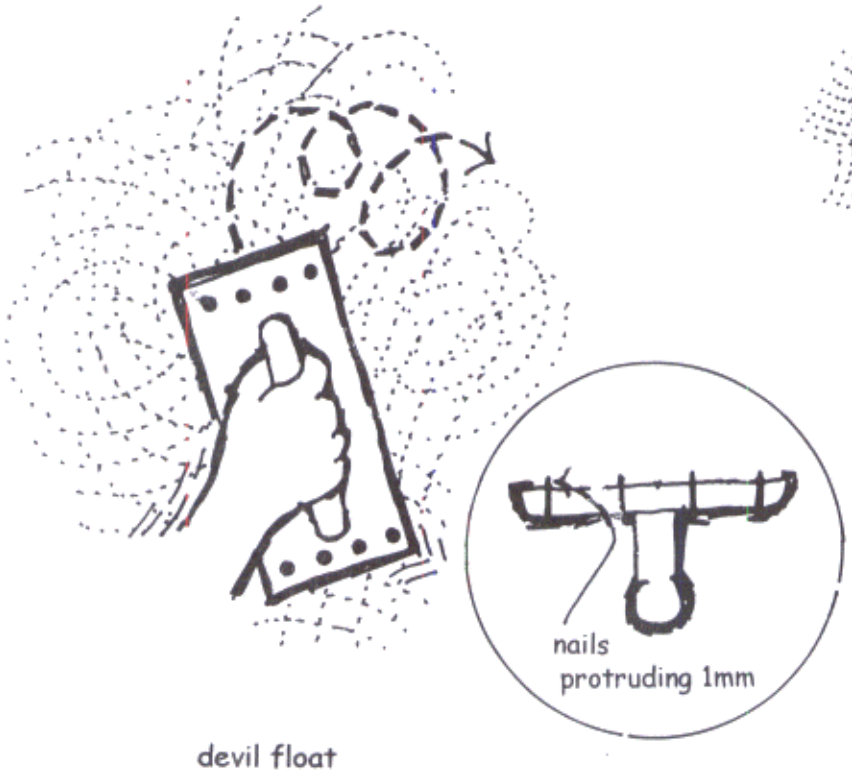
scouring with a wood float

Timing is also important. For non-hydraulic lime the mortar must be firm enough that the scouring will not just re-work the mortar, but not so firm that the cracks cannot be closed up. This can be anything from several hours to several days depending on conditions. For hydraulic lime renders once the mortar starts to firm up (which is usually within an hour or two of application) great care must be taken not to disturb the main body of the coat or the hydraulic set may be damaged. So, avoid vigorous scouring after this time, and simply press in the cracks to close them up.

• Always ensure that the previous coat is damp before applying the next one. If applying a fairly fine top coat, keying of the previous coat is best carried out using a comb scratcher or a devil float which creates a finer key than a lath scratcher. If the keying is too coarse it may well result in cracking of the top coat along the lines of the key because the render will be comparatively much thicker in these places.



comb scratcher



devil float

• The final appearance depends on the type of mortar used for the top coat and the tools used to finish it. Scouring with a wood float will result in a fairly open texture suitable for the majority of external renders on vernacular buildings. For internal plastering a combination of wood and sponge floats and a plasterers trowel can be used to create a smooth polished finish. A traditional type of finish for simple cottages and farmhouses is known as roughcast. A slurry of mortar containing some quite coarse particles of gravel is thrown onto the top coat of render from a dashing trowel. This creates a rough, slubby texture with a large surface area which helps in allowing the wall to breathe, but requires some expertise to avoid a porridgey mess.

• The work must be protected to prevent rapid drying. Both hydraulic and non-hydraulic limes must be kept slightly damp but at the same time air must be allowed to circulate. If using polythene or tarpaulin it should be fixed so that there is a gap between it and the wall. Remember that water will drain down through the render under gravity so the upper parts of a wall will start to dry out faster than the lower parts and you may need to spray these areas more frequently. Frost can be a particular hazard to a young render as it can cause damage weeks after the render was applied, especially if preceded by heavy rainfall. It is a fallacy to believe that by using hydraulic lime or a pozzolanic additive you can "beat the frost". It is only the initial setting which takes place by hydraulic reaction and the mortar still requires a long period of time to carbonate and strengthen. If hard frost is forecast within a couple of months of application then ideally the render should be protected by hanging polythene, bubble wrap or hessian over it, although on most buildings this may be impossible. A render which survives its first winter unscathed is more likely to wear well subsequently.

REPAIRING RENDER

If patches of render have fallen off cut back the edges to sound plaster. The best tool for this is a craft knife. You can cut back using a bolster chisel but you risk loosening adjacent plaster. Ensure that the edges of the patch are cut square to provide a key for the new mortar, and eliminate feather edging.

Where render is cracked or hollow it may be possible to consolidate and save it and further advice should be sought before hacking it off, especially if it is believed to be very old. However if it is beyond repair or not worth saving hack it off, cutting back round the edges to sound plaster.

Rake out any loose pointing in the wall behind and repoint roughly. Brush out loose dust and apply the render in thin coats following the guidance above and taking care to ensure that it is well pushed in beneath the undercut edges of existing plaster. Apply the final coat with a neat butt joint between the old and new and with a slight bulge in the middle of the patch so that the final consolidation will create a flat patch, flush with the surrounding render. Do not feather the edge of the patch over the surrounding plaster. Push back and consolidate the patch with a wood float. For small patches it is best to use miniature wooden floats which can be made by fixing a small handle to a short piece of batten and rounding off the edges with sandpaper.

LIMEWASHING

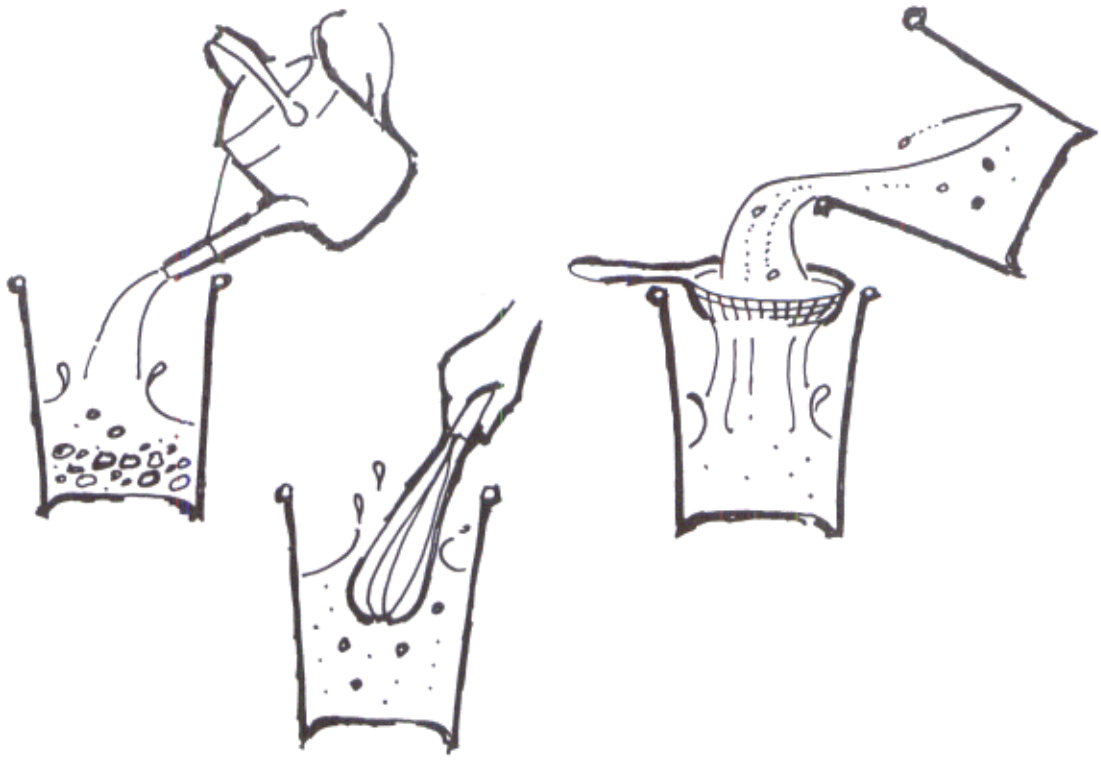
LIMEWASH

Limewash is the traditional paint for decorating rendered and plastered surfaces. In its basic white form it is known as whitewash but it can be tinted with pigments to form colourwash. It provides protection but allows the wall to breathe. Its use has been largely superseded by modern masonry paints but these are much more expensive and even the so called micro-porous paints are not as porous as limewash. Additional protection for external renders can be achieved by adding a water repellent such as tallow or linseed oil to the wash, although this reduces the porosity. Limewash is available from specialist suppliers, and it is easy to make from lime putty.

MAKING LIMEWASH

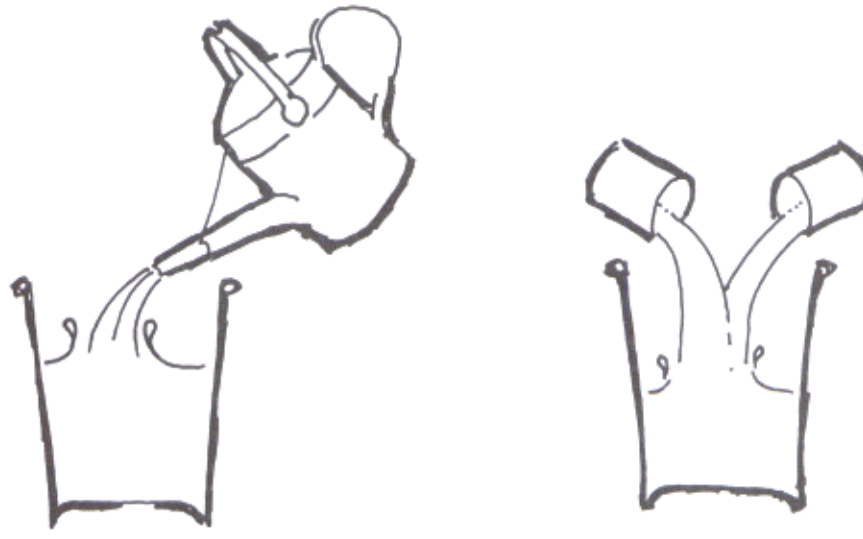
- Limewash is best made from mature lime putty, ideally at least one year old. If young lime or dried lime is used the limewash will be more likely to flake and wash or brush off. Unfortunately many suppliers' oldest lime putty is three months old, so it is a good idea to try to buy it well in advance of when you might need it. Remember to wear protective clothing and goggles as making and using limewash inevitably causes splashes.

- Put a couple of trowel-fulls of lime putty into a clean bucket and add a few inches of water. Mix gently using an old whisk or potato masher to break up the lime and create a thick creamy mass. Add more water mixing all the time until the mixture is the consistency of single cream. For large quantities you can use a power drill with a plaster mixing attachment. Pour the mixture through a sieve into a second bucket.



• If using tallow melt a dessert spoonful of shredded tallow in hot water and add to the limewash stirring briskly. Alternatively add two spoonfuls of linseed oil to a bucket of limewash (about 3% by volume)

• Add more water until the limewash is the consistency of milk. It is now ready for use. It will be much thinner than normal commercial paints and must be applied in several coats to achieve an opaque covering. For bare plaster you will probably need at least five coats to give good obliteration. Avoid the temptation to use a thicker consistency and fewer coats as you will increase the risk of the limewash crazing and flaking off.



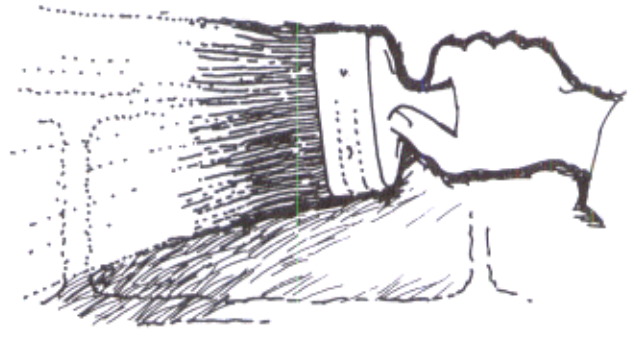
• For a coloured wash mix some pigment in hot water and stir well. Stir the pigment into the limewash until the colour in the bucket is considerably darker than the required shade as it will lighten significantly as it dries. However, do not add large quantities of pigment in an effort to obtain strong or dark shades of limewash as the addition of too much pigment weakens the limewash making it powdery and liable to brush off. Limewashes are traditionally pale, earthy colours. For stronger colours it is necessary to add less water so that the limewash is thicker and there is proportionally more lime to bind the pigment but there is then the risk that the limewash will crack as it dries so it is best to stick to a thin, watery limewash and pale colours.

It is extremely difficult to make a second batch of limewash exactly the same colour as the first unless you record accurately the amounts of lime, pigment and water used. It is best to mix enough limewash for the complete job in one go, but to be on the safe side, keep a note of the recipe used.

APPLYING LIMEWASH

• Brush down the wall using a stiff brush to remove loose debris. Always dampen the wall before applying the limewash. If applying to new lime render wait until the render has hardened but is not fully carbonated, usually about a week or so depending on the rate of drying.

• Use a large bristle brush to apply the limewash in a thin coat, working it well into any cracks or crevices in the surface. The limewash will be little thicker than water and liable to drip and dribble. Protect floors and furniture with polythene or dust sheets and protect yourself with goggles, gloves and overalls. Remember to stir the bucket of limewash from time to time as the particles of lime will tend to sink, and if you have added tallow or linseed oil it will start to separate out.



• Protect the newly limewashed surface from rain or rapid drying using polythene sheeting, fixed so that it is not in direct contact with the painted surface.

• Apply the limewash in several coats until the desired degree of opacity is achieved. For new plaster or render at least four or five coats will be needed, but for freshening up existing limewash two or three coats will be sufficient. Allow a day for each coat to dry before dampening the wall and applying the next coat.

FURTHER READING

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Wingate, Michael : An Introduction to Building Limes. Society for the Protection of Ancient Buildings: Information Sheet 9 1988

SUPPLIERS

Quicklime

ARC, Batscombe Quarry, Cheddar, Somerset. 01934 742733

Bleaklow Industries Ltd, Hassop Avenue, Hassop, Bakewell, Derbyshire. 01246 582284

Buxton Lime Industries Ltd, Tunstead Quarry, Wormhill, Buxton, Derbyshire. 01298 768444

H J Chard and Sons, Albert Road, Totterdown Bridge, Bristol. 0117 977 7681

Hargreaves Quarries Ltd, Hartley Quarries, Kirkby Stephen, Cumbria. 0176 83 71479

RMC Industrial Minerals, Hindlow, Buxton, Derbyshire. 01298 71155

Shillingstone Lime and Stone Co, Shillingstone, Dorset. 01258 860388 (quicklime)

Lime putty

R H Bennet, The Lime Centre, Nr Winchester, Hampshire. 01962 713636

H J Chard and Sons, Albert Road, Totterdown Bridge, Bristol. 0117 977 7681

Chichester Cathedral Works Organisation, Chichester, West Sussex. 01243 784225

Limebase Products Ltd, Walronds Park, Isle Brewers, Somerset. 01460 281921

Rose of Jericho at St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83662

J & J Sharpe, Merton, Okehampton, Devon. 01805 603587

Twyford Lime Products, 1 Twyford Place, Tiverton, Devon. 01884 255407

Mike Wye and Associates, Glebe House, Buckland Filleigh, Beaworthy, Devon. 01409 281644

Rory Young, 5 Park Street, Cirencester, Gloucester. 01285 658826

Hydraulic lime

Chichester Cathedral Works Organisation, Chichester, West Sussex. 01243 784225 (imported)

Hydraulic Lias Limes Ltd, Tout Quarry, Chessils Lane, Charlton Adam, Somerset. 01458 223179

Limebase Products Ltd, Walronds Park, Isle Brewers, Somerset. 01460 281921 (imported and local)

Rose of Jericho at St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83662 (imported)

Shillingstone Lime and Stone Co, Shillingstone, Dorset. 01258 860388 (quicklime)

Telling Lime Products, Strawberry Lane, Willenhall, West Midlands. 01902 366718 (imported)

Hydrated high calcium lime (dried, bagged lime)

Available from most builders merchants

Ready mixed mortars

R H Bennet, The Lime Centre, Nr Winchester, Hampshire. 01962 713636

H J Chard and Sons, Albert Road, Totterdown Bridge, Bristol. 0117 977 7681

Limebase Products Ltd, Walronds Park, Isle Brewers, Somerset. 01460 281921

Rose of Jericho at St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83662

J & J Sharpe, Merton, Okehampton, Devon. 01805 603587

Twyford Lime Products, 1 Twyford Place, Tiverton, Devon. 01884 255407

Mike Wye and Associates, Glebe House, Buckland Filleigh, Beaworthy, Devon. 01409 281644

Limewash

R H Bennet, The Lime Centre, Nr Winchester, Hampshire. 01962 713636

H J Chard and Sons, Albert Road, Totterdown Bridge, Bristol. 0117 977 7681

Liz Induni, 11 Park Road, Swanage, Dorset. 01929 4237756

Limebase Products Ltd, Isle Abbotts, Somerset. 01460 281921

Potmolen, Warminster, Wiltshire. 01985 213960

Rose of Jericho at St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83662

J & J Sharpe, Merton, Okehampton, Devon. 01805 603587

Twyford Lime Products, 1 Twyford Place, Tiverton, Devon. 01884 255407

Mike Wye and Associates, Glebe House, Buckland Killeigh, Beaworthy, Devon. 01409 281644

Western Decorating Supplies, Old Creamery, Lynx Trading Estate, Yeovil. 01935 411707

Pigments

Brodie and Middleton Ltd, 68 Drury Lane, London. 0171 836 3289 (mail order service available)

Cornelissen and Sons, Great Russell Street, London. 0171 636 1045 (mail order service available)

Limebase Products Ltd, Walronds Park, Isle Brewers, Somerset. 01460 281921

J Myland Ltd, 8 Norwood High Strret, London, SE27 9NW. 0181 670 9161

Rose of Jericho at St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83662

Hair

ETP Sales, Goldcroft, Yeovil, Somerset. 01935 33538

H J Chard and Sons, Albert Road, Totterdown Bridge, Bristol. 0117 977 7681

Limebase Products Ltd, Walronds Park, Isle Brewers, Somerset. 01460 281921

Mayfield Exports Ltd, Wheatly, Oxford. 01865 58874

St Blaise Ltd, Westhill Barn, Evershot, Dorset. 01935 83226

Linseed Oil

Raw linseed oil is available from builders merchants, hardware shops, decorating suppliers and art suppliers.

Tools

Sculptors' tools including small spatulas which are useful for repointing can be obtained from

South Western Industrial Plasters, The Old Dairy, Hawk Street, Bromham, Devises, Wiltshire. 01380 850616 (mail order service available)

Alec Tiranti Ltd, 70 High Street, Theale, Reading, Berkshire. 01734 302775 (mail order service available)

and at 27 Warren Street, London. 0171 636 8565

FURTHER INFORMATION

For further information contact the Historic Buildings Advisor or the Conservation Architect at the address shown on the back cover.

This publication has been prepared by South Somerset District Council's Conservation and Environment Unit. Written by Alison Henry and illustrated by Adron Duckworth. March 1999.

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