



Lime mortar v cement

Ian Pritchett of IJP Building Conservation discusses traditional methods for today's buildings

Lime is the principal binder of most traditional mortars plasters and renders. The Romans brought the technology of lime in building here with them 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. Although lime mortar and plaster was mainly used in pre 1900 construction and it is still primarily seen as method of maintaining and repairing traditional buildings, an increasing number of professionals are discovering that modern buildings can benefit greatly from its use.

The use of lime declined throughout most of the twentieth century, but increasingly, over the last 20 years, it has been recognised that hard, cement-rich mortars are unsuitable for use on old buildings, and lime is enjoying a strong revival in the building conservation industry. Much of the skill and knowledge needed to use lime successfully had dwindled, so when lime began to be more widely specified for conservation work there was a lack of suitably experienced and skilled craftsmen. The practical techniques required for the use of lime can be mastered by anyone with good building skills or a craft aptitude and the adoption of certain basic principles.

Traditional uses

Traditional applications see lime being used in many different ways. Lime mixed with sand to form lime mortar can be used for bedding masonry and for pointing, rendering and plastering (often with animal hair added). For the very fine joints in ashlar masonry or gauged brickwork pure lime putty can be used for bedding, pointing and repairs.

Lime can also be mixed with carefully chosen aggregates (sands and stone dusts) to make repair mortars for damaged stonework. Lime also has valuable applications for specialist stone cleaning and conservation techniques.

Lime putty can be diluted with water to make a lime wash for painting both internal and external walls, with pigments being added to produce a coloured lime wash.

The Benefits of Lime in new buildings

There are many advantages of using lime mortar. Traditional building construction is based on the use of relatively soft and porous materials such as stone, brick, timber and earth, 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 to 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.

Cement has very different properties to lime. Cement pointing is very hard and brittle, much less porous and sometimes completely waterproof. Its use on traditional masonry may have a damaging effect in one of 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 and cracking the masonry.

Further damage is caused by rainwater and dampness within the masonry. 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 effect 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.

Soft lime mortar allows moisture movement, being more porous than the masonry, encouraging evaporation and salt deposition in the mortar joints. 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, with less loss of important historic fabric.

Using 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 capillary action into these cracks and then diffuses into the wall. Once inside the wall this moisture, together with any rising damp and water vapour generated by daily life, is trapped, as it cannot evaporate through the hard, impermeable render. The moisture levels start to build up in the wall and the moisture shows on 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 moisture within the wall and keeping the surfaces dry.

Using lime is also much more aesthetically pleasing especially if you are building a new home in a traditional style as the finish you can obtain with a lime mortar or render is far more in keeping. The mortar colour depends on the sand you are using but you usually get a creamy/sandy colour mortar which complements brick colours and helps to bring them to life. Similarly, lime renders and plasters have a softer appearance than cement renders and plasters.

Types of Lime

Lime is made by quarrying limestone and heating it in a kiln. The purity of the limestone and the burning temperature will affect the qualities of the finished product. Impure lime-stones (containing silica and alumina) produce hydraulic limes. These set harder and faster than pure limes. They can also set in wet (even under-water) conditions. These types of limes are suitable for modern construction because they set relatively fast and strong enough to cope with the stresses of cavity construction.

Environmental Issues

In the UK 3,000 million bricks are fired annually consuming large quantities of fuel and adding significantly to CO2 emissions. Buildings constructed with lime mortars can be altered easily and bricks/stones reused. Indeed the masonry can be reclaimed entirely if a building has completed its useful life. This is why architectural salvage yards have second hand bricks to sell. Bricks bound together with cement mortars, however, can generally never be recycled - except as hard-core. This is especially pertinent to modern commercial buildings, which may be demolished after only a few years. If we continue to use cement mortars we will have to continue making billions of high energy bricks each year. During the manufacturing process, the firing temperature between cement and lime is significantly different. Lime is produced at a temperature of around 900 to 1100°C. Cement is produced at 1200 to 1500°C. More energy is required to produce a tonne of cement than a tonne of hydraulic lime thereby increasing CO2 emissions. Additionally, the bulk density of lime is half that of cement, leading to overall energy savings when using lime of approximately 30 to 50%. Lime mortars will also re-absorb some CO2 during their setting process. Since cement production is responsible for 1500 million tonnes of CO2

each year (that's 10% of all worldwide CO2 production) the environmental argument for lime in new building is a compelling one.

The Future of Building

150 years ago Portland cement was considered as a specialist material and no one thought it would catch on in mainstream building because it required grinding during its manufacturing process. However advances in industrial processes and the demand for faster building, particularly after the 2nd world war, changed the market conditions and cement took off. Portland cement is a fantastic material for mass concrete and engineering structures, but the last 50 years have shown that it is not the greatest for mortars, plasters and renders as it is too hard, too rigid and too impermeable.

This has been particularly noticeable where it has been used on historic buildings. We are now at a cross roads, there is a need to build millions of new homes over the coming decades, but environmental issues are becoming more important to us. There are people who think that lime will never take off again in mainstream building, but small, subtle changes in the market conditions could change the future. The combination of lime with modern technology and higher demand could bring the cost down. The introduction of a carbon tax, or legislation setting targets for recycling of buildings could make cement impractical and therefore make lime the natural choice. The future is green - lime green!

Lime cures the damp problems of the Parish Church of St James during a recent restoration.

The Parish Church of St James in Finchampstead, Berkshire has a 12th century nave and chancel, a 14th century chapel with later alterations and an 18th century tower. It was built from a mixture of chalk, ironstone, flint and brick. Architect Nick Whiteley of the Whiteley & Beach Partnership, on behalf of Finchampstead Parish Council, asked IJP Building Conservation Ltd to comment on the failure of the internal plasterwork and the damp that was evident in that area.

IJP surveyed the church, taking a holistic view of the problems, advising Whiteley & Beach Partnership to address the root cause. The initial investigation diagnosed that the main culprit was the modern external sand and cement render, which was trapping moisture, resulting in high levels of damp and salt contamination. By removing the existing render and reapplying a lime based render, the damp problem would be much improved. Other culprits were identified as the internal modern plaster and decorations, but for budgetary reasons these could not be dealt with immediately.

The modern cement render that had been applied over the traditional fabric of the church, creating a hard and brittle surface, had cracked due to the slight and continued movement in the wall. Rainwater had been drawn by capillary action into the cracks and then diffused into the wall.



The church soon after work started



The church after completion of the work

Once inside the wall this moisture, together with any rising damp, became trapped, as it could not evaporate through the hard and impermeable render.

The moisture levels had built up inside the walls, diffusing towards the inner surface, resulting in internal dampness and damage to plaster and decorations. In a church of this age, even applying a waterproof render can actually increase levels of damp inside the building, whereas porous lime render encourages evaporation of moisture from its surface, which helps to minimise the effects of penetrating and rising damp.

IJP carried out further investigations, establishing what previous finishes had been used on the building (in this case, lime render and lime washes), as well as the type and condition of the background structure and probable ease of removing the existing render. From this initial investigation IJP then stripped off all of the existing sand and cement render, revealing areas of loose masonry and many deep voids.

It was necessary to dub out the masonry, incorporating new flint and hand-made clay tiles with a fat lime mortar to fill the voids. The resulting process gave a flush and level surface on which the new lime render would be applied.

IJP applied a two-coat render scheme, using haired fat lime, following the undulations of the base wall. On top of this base coat, four coats of lime wash were applied with a yellow ochre pigment. A number of the church windows also needed attention. Minor mortar repairs were made to improve the weathering details of the masonry. A lime shelter coat (a mix of lime putty and silver sand) was applied onto the surface of the stone.

The windows were finally finished with 4 protective coats of lime wash. This finish recreated the probable original appearance of the windows, as traces of lime wash were found on them.

The results speak for themselves. The external appearance of the church has been altered and now looks much as it would have done for the majority of its life. IJP has reversed the well intentioned, yet damaging effects, created by the use of modern materials, now creating the conditions needed to protect the building for centuries to come. Parishioners now have a church which is a lot more healthy - and pleasant to look at.

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