INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

The use of lime & cement in traditional buildings

HISTORIC SCOTLAND

Introduction

Scotland has a long tradition of building with stone and lime stretching back to Roman times. A large proportion of Scotland's buildings constructed prior to 1920 used lime mortars in both construction and finishing. From the mid Nineteenth Century the use of ordinary Portland cement (OPC) mortars became increasingly common. In the Twentieth Century it became the norm for new construction, and became increasingly used to repair traditional buildings originally built using lime mortar. This has a negative visual and practical impact, and can have a serious effect on the condition of the building. The construction industry has almost forgotten why lime was used, and is having to re-learn the skills to use it effectively.

In the majority of applications lime has significant performance and visual benefits over cement mortar, particularly in relation to traditional buildings. Where modern mortars have been introduced into traditional masonry structures, the consequential rate of decay can be alarming. The purpose of this INFORM is primarily to discuss the external use of lime and cement mortars in relation to traditionally constructed buildings.

Traditional stone and lime construction

Cover; Traditional lime pointing (bottom) with cement pointing (top) (Photo: Ingval Maxwell)

What is a mortar?

A mortar is a material in a plastic state which can be trowelled into place and sets insitu. It consists of ;

- **A binder** (lime, Ordinary Portland Cement (OPC), clay)
- **An aggregate** (sand or gravel)
- **Water**

The Binder

Various combinations of binder types, production methods and relative quantities affect the qualities and purpose of the mortar that is produced. This flexibility can be used to create mortars for specific situations.

The most common difference between mortar types is the nature of the binder. This INFORM will focus on lime and cement (although clay was perhaps more commonly used in Scotland than is often appreciated). The binder affects the physical and chemical properties of the mortar, its strength, how quickly it hardens or sets, and its reaction with surrounding materials.

Lime mortar

Lime mortar mixes, whether for building, re-pointing, harling, rendering or plastering, are essentially made from the same material. Building lime is produced by burning a naturally occurring form of calcium carbonate (such as limestone, chalk or sea shells) to form quicklime by driving off carbon dioxide. This is done using a kiln and the process was once commonplace across Scotland. Currently building lime is supplied in bag form. The quicklime is mixed with water (this can produce a vigorous reaction which generates heat) to form lime putty in a process

Poorly executed repairs in portland cement

known as slaking. This is a skilled procedure requiring specialist training.
To differentiate between how lime mortars work, they can be classified as either non-hydraulic or hydraulic.

Non-hydraulic lime comes in two forms – a dry powder or a putty. Lime putty is most commonly used for internal plastering, and the dry powder (more commonly known as builders lime) is used as an additive to cement mortars to improve workability.

Hydraulic lime is produced from a limestone which contains clay-based minerals. Hydraulic lime is available as a dry powder. It is commonly used for external work as it can withstand more aggressive conditions on buildings. In part, hydraulicity is a function of the mortar's ability to handle moisture. Natural Hydraulic Limes (NHL's) are now classified by British Standard according to their compressive strength (as with modern cement mortars) in three categories; NHL 2, NHL 3.5 & NHL 5. However, strength is one of the less important characteristics of a lime mortar, which flows and moves with the building in different environmental conditions.

Aggregate

The aggregate makes up the bulk of a lime mortar mix and is fundamentally important to the mortar's performance. Aggregates are thought to affect the setting of the mortar chemically, and by influencing air and water movement by the shape and size of the different grains. Sand and gravel are the most commonly used aggregates. For harling, render and plaster base coats, and re-pointing masonry joints above c.8-10mm wide, a coarse, well-graded sand is normally required.

For finer render and plaster finishing, and repointing narrow masonry joints, a sharp finer sand has to be used. Unlike a cement mortar (the colour of which is normally grey), the colour of a lime mortar varies and comes primarily from the sand that is mixed in. The correct choice of materials is therefore very important, particularly when undertaking patch repairs.

Other additives can be used in lime mortars to influence its performance. Pozzolanic materials such as brick dust and fly-ash promote setting, whilst the incorporation of animal hair has been used to increase the mortar strength for internal plastering and external finishes.

Cement mortar

Ordinary Portland Cement is made by heating limestone with clay or sand in a kiln in a controlled manner to produce "clinker". Varying amounts of the mineral gypsum are added to this to give the desired setting properties. The material is supplied in bag form. The addition of water causes a reaction and the cement to set. The combination of cement, aggregate and water in different proportions forms concrete, cement plaster and cement mortar.

Putting additives into cement can increase the workability of the mix, for example to allow its use as a render for external surfaces. Like lime mortars, pozzolans can also be added to affect the setting characteristics. Colour additives can also be incorporated. There are five types of Portland cement, each with different performance and setting characteristics. Type 1 is what might be described as common cement and is the most widely used.

Lime and cement mortars compared

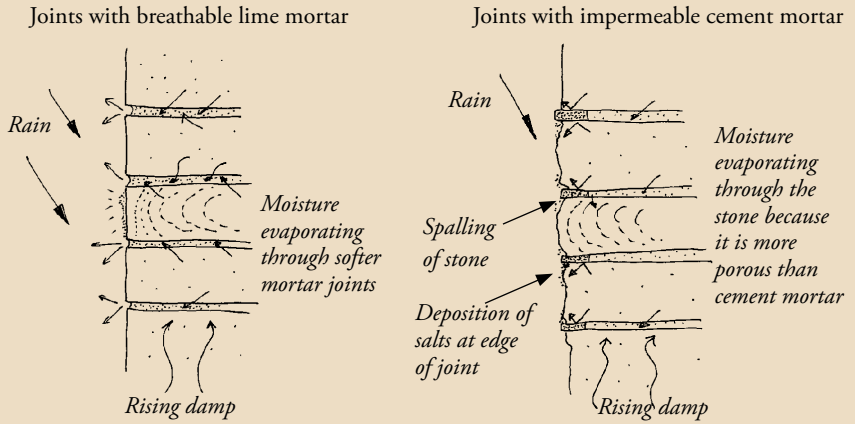
Lime and cement have characteristics which make them ideal for specific applications. However, significant problems can arise when cement is introduced to buildings originally constructed and previously maintained using lime mortars.

Weatherproofing and 'Breathability'

Lime mortared and rendered stone buildings have a natural ability to both hold and evaporate moisture from the walls, thus maintaining a state of balance with the surrounding atmosphere. Lime mortars and harled (rendered) surfaces can therefore absorb and evaporate moisture freely. In less permeable masonry, such as walls built of granite, the function of the lime mortar joints becomes more critical to allow for the free passage of moisture.

Lime drying out quickly after heavy rain

Moisture movement within traditional stone and lime



The method by which lime mortars enable the passage of moisture is critical in other ways. The process allows a degree of control over condensation within the building. This helps create a better thermal performance than a building which is repaired with cement mortar and renders, as these walls are likely to remain more permanently damp. In direct contrast, the use of cement mixes for pointing repairs and the application of hard cement renders dramatically reduces the passage of moisture, slowing drying out times considerably and increasing the risk of internal condensation problems.

Masonry Decay & Appearance

Impermeable cement mortars can also accelerate stone decay. As there is little moisture movement allowed through the joints, moisture is concentrated behind the cement barrier. This forces water to repeatedly move into and through the stone causing the surrounding masonry to sacrificially deteriorate. Any soluble salts contained in the cement mix can also contribute to this process, causing further damage through a build up of powdery deposits on the wall face (efflorescence).

Performance aside, re-pointing with cement also has a negative visual impact as it tends to be applied very superficially. This inevitably gives the appearance of stones awash in a sea of grey mortar. Any subtle variations in texture and form of the original masonry build, and colour of the original lime mortar are lost, and this is often exacerbated when patch repairs are carried out.

Poor quality cement pointing can have a poor visual impact

Movement

Lime mortars have an inherent flexibility which hard-setting cement mortars do not. Small scale movements caused by subsidence or settling, and thermal movement can generally be accommodated. Hairline cracks in lime mortars chemically seal themselves, and are often described as being 'self healing'. Cement mortars do not have any of these characteristics and will fracture, fail and encourage more moisture to enter the walls. Over time this can further accelerate the decay of adjacent stonework.

Which Mortar to use ?

In the repair and maintenance of traditional buildings it is always best practice to retain as much of the original material as possible. Where that is not possible, the most effective alternative involves the understanding and use of materials and techniques that were employed in the original construction. This logic applies to both lime and cement mortars, for it is recognised that the original use of cement mortars is just as worthy of conservation as their lime counterparts. But care needs to be exercised in making this judgement due to the widespread use of replacement cement mortars over the past 60 – 70 years.

Where failed mortars do require replacement, evaluation of their function is essential. The masonry condition, prevailing climatic conditions, and visual appearance (texture and colour) should all be considered. It should also be remembered that the natural weathering process could also have changed the appearance of the mortar from its original application. It is advisable to seek the advice of a specialist in this field as it is possible to obtain a detailed analysis of the original mix to ensure accurate re-pointing can be undertaken.

An initial investment in getting the right specification for materials and the proper application will ensure higher performance in the longer term, and save on future maintenance costs.

Key Points:

- Due to the many historic variations in the original materials used, and their subsequent interaction with other elements, the use of an 'off the shelf' mortar is not a realistic option.
- Lime mortars are a component of a traditional building system and a holistic approach to maintaining and repairing the building is required.
- Any replacement mortar should be no stronger, or harder, than the material it is bonding.
- In most instances durability is more important than strength.

Useful Contacts

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Further reading and information

TAN 1 - *'Preparation and Use of Lime Mortars'*
ISBN 1 903570 42 5

TAN 19 *'Scottish Aggregates for Building Conservation'*
ISBN 1 900168 69 3

British Standard BS EN 459:1

Maintaining Your Homes: A Short Guide for Homeowners
ISBN 1 903570 93 X

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