

APPENDIX D: HLM PROJECT - HOT LIMES DEMONSTRATION WORKSHOP DRIMINAGH CASTLE

25th November 2014

The Workshop comprised a series of practical demonstrations and discussion on the use of hot-lime and earth mortars including the findings of the Hot Lime Mortar Project being the technology transfer programme between Ireland and Scotland 2014.

Demonstration by Nigel Copsey, Pat McAfee and Andy Bradley on hot-lime and clay mortars with support from Craig Frew & Bill Revie of the HLM Project team.

The practical demonstrations concentrated on; hot-lime, hybrid hot-lime, clay, quicklime and clay mortars. The demonstrations and discussions were specifically for specifiers and practitioners and also building professionals newly acquainted with lime.

The Workshop was free for BLFI members. It had a 5 hour which includes BLFI Membership 2014- 2015.

Over 60 attended and 16 new Members enrolled with the

Nigel Copsey began working with stone as a drystone as a stonemason and carver at Weymouth College in Dorset, stonemason working mainly in the field of stone and South-West, he has carried out projects across England and is a fully accredited member of the United Kingdom information please see <http://www.nigelcopsey.com/#2>

CPD status. The cost for non-members was €60

BLFI.

waller in Cornwall. After eight years, he trained becoming established as a lettercutter and building conservation. Based originally in the more recently in Vermont and Andalucia. Nigel Institute of Conservation. For further

Course Co-ordinator: Pat McAfee – Stone Works

Mason, Instructor, Author of *Lime*

PROGRAMME

10.00 Registration, tea and coffee

10.30 Welcome and introduction

10.40 The HLM Project: Irish-Scottish Hot Lime Mortar Technology Exchange Programme

11.10 Safety

11.25 Materials, quicklime, NHL, sand, clay

11.45 Mix ratios

12.00 Practical demonstration of hot-lime mortar mixing

12.15 Practical demonstration of using hot-lime as a mortar for building with stone

1.00 Lunch

1.30 Practical demonstration of mixing hybrid hot-lime mortar

1.45 Practical demonstration of using hybrid hot-lime mortar

2.15 Clay – testing for suitability

2.30 Practical demonstration of earth and sand mixing

2.45 Practical demonstration of earth, sand and quicklime

3.00 Summary, questions and answers

APPENDIX E: Lime Safety Information Sheet

All limes are classified as hazardous materials but no more than OPC (Ordinary Portland Cement). In solution lime has highly alkaline qualities and acts as an irritant.

LIME IS AN IRRITANT TO:

- Eyes - Contact with eyes can cause ocular lesions and severe and possibly permanent damage can

occur without immediate & adequate treatment. Chemicals with an alkaline pH value, such as lime dust, cause irreversible damage which can result in blindness.

- **Skin** - When mixed pH is raised and can irritate and dry out skin and prolonged contact with the skin can cause sensitivity.
- **Respiratory tract and Mucous membranes** - Lime is caustic and ingestion/inhalation (of a significant quantity) may damage digestive tract and may cause burns to the mouth, oesophagus and stomach.

Precaution must always be taken and appropriate PPE (Personal Protective Equipment) worn while using lime.

All Modern Specialist manufacturers and suppliers of lime products provide guidance on:

- the physical properties of the product,
- care required and suitable precautions to be taken when working with the product, and
- information on classification and labelling.

They will also provide lime safety data sheets on request.

Safety at work is covered under the relevant Health & Safety Acts and enforced by the Health & Safety Authority(HSA). PART D Regulations under the Safety, Health and Welfare Act 2005 (S.I. No. 10 of 2005) refers to materials and workmanship and states the following:

D1 Materials and workmanship

All works to which these workmanship regulations apply shall be carried out with proper materials and in a workmanlike manner.

D2 Letterplates

A letter plate aperture shall be so positioned at a reasonable height above ground level so as not to endanger the health and safety of persons using such apertures.

D3 Definitions

“Proper materials” means materials which are fit for the use for which they are intended and for the conditions in which they are to be used, and includes materials which:

- (a) bear a CE Marking in accordance with the provisions of the Construction Products Regulation;
 - (b) comply with an appropriate harmonised standard or European Technical Assessment in accordance with the provisions of the Construction Products Regulation; or
 - (c) comply with an appropriate Irish Standard or Irish Agré- ment Certificate or with an alternative national technical specification of any State which is a contracting party to the Agreement on the European Economic Area, which provides in use an equivalent level of safety and suitability;⁴ [224]
- “Agreement on the European Economic Area” means the Agreement on the European Economic Area between the European Union, its Member States and the Republic of Iceland, the Principality of Liechtenstein and the Kingdom of Norway as published in the Official Journal of the European Communities (O.J. No. L1, 03.01.1994, page 3); “Construction Products Regulation” means Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.”

Appropriate PPE which should be worn at all times when using lime include:

- Safety Glasses/Goggle
- Dust Mask
- Full coveralls (or full length trousers and long sleeve top)
- Waterproof or nitrile gloves
- Safety Glasses

CHOOSING THE RIGHT PAIR OF SAFETY GLASSES

Safety glasses are very readily and very cheaply available. Prescription safety glasses are now also available. When choosing a pair there are a number of things to look out for:

- Make sure they wrap around the face with panels on sides and top for added protection
- Choose a polycarbonate lens which is very hard wearing and most appropriate for construction work
- Also look for extra's like **anti scratch, anti fog, anti static, uv protection etc**
- Look for CE symbol and the manufacturer's logo. The CE marking certifies that a product has met EU consumer safety, health or environmental requirements and must appear on frame and lens.
- There should also be an EN standard on both the lens and the frame to which the glasses are certified. Each

test is different but specific for their designed use and worth checking.

PPE HAS ITS LIMITATIONS BECAUSE:

- PPE only protects the wearer.
- It is ineffective if not working or fitted properly.
- Theoretical levels of protection are seldom reached in practice.
- The use of PPE always restricts the wearer to some degree.

The psychological effect of PPE may be such that the individual wearing the PPE feels more protected than he or she actually is.

FIRST AID MEASURES

Prevention

Avoid all prolonged contact with skin, avoid inhalation or contact with eyes by using barrier creams and wearing adequate PPE at all times.

Treatment

- Contact with eyes - Rinse immediately and abundantly with clean water, consult a doctor and/or ophthalmologist.
- Contact with the skin - If the Lime is dry, remove as much powder as possible, then wash with clean water. If the Natural Hydraulic Lime is mixed wash abundantly with water. Be careful to ensure that no lime remains between the skin and watch, shoes or clothes.
- Inhalation - In the case of inhalation of a large quantity, bring the subject away from the work area into fresh air and consult a doctor in the case of any respiratory symptoms.

It is also recommended to carry a Diphoterine (or similar) neutralising eyewash capsule at all times which contains a unique solution for the Emergency First Aid decontamination of chemical splashes in the eyes or on the skin .

- Removal of chemical from the surface of the tissue.
- Absorption and neutralisation of the aggressive chemical molecule remaining on the tissue surface.
- Attraction, absorption and neutralisation of the aggressive chemical molecule already penetrating the tissue

– It eliminates 20mins of flushing out but should be followed by a trip to the doctor/ophthalmologist as precaution.

Characteristics:

- Waterproof and compact
- Does not require a specific installation and maintenance.
- In conformity with EN 15454-4
- EC certification
- Permits quick action
- Ergonomic eyecup facilitates the eye opening
- **2 year shelf life**
- Use for one eye only
- **Delay to start the rinsing - Maximum 10 seconds**
- Accessory belt available

APPENDIX F: BLFI Safety Guides

Introduction

Lime is a generic term used to describe a broad range of lime based materials. These materials include Quicklime, Hydrated Lime & Natural Hydraulic Lime. All of these materials are classified as “Hazardous” under EU Regulation 1272/2008.

When the correct handling techniques and personal protective equipment are used, lime poses a low risk to the health and safety of workers.

In order to implement these techniques, appropriate awareness and training in the use of lime and lime based materials must be provided to workers. It is the purpose of this document to provide information in this area. This document does not purport to be a full Safety Data Sheet – it is recommended that the official SDS and Appendix of Exposure

Scenarios be consulted prior to handling any lime based material.

The classifications and recommendations contained within this document also apply to cement based products, although classified under older legislation (67/548/CEE).

Description and Properties

Quicklime : A strong alkali which reacts with water generating significant heat

Hydrated Lime : A strong alkali made from quicklime which does not react with water

NHL : A strong alkali which does not react with water. Has cement like properties

Classification

All lime based materials carry common hazard and safety statements to provide the end users with the information needed to carry out their work in a safe and controlled environment. In accordance with Regulation 1272/2008, the following statements must be considered when handling lime based products. For clarity, the older designations under 67/548/CEE are also provided in Table 1.

Material	67/548/CEE	1272/2008
Quicklime Hydrated Lime NHL	R37 Irritating to Respiratory System	H335 May Cause Respiratory Irritation
	R38 Irritating to Skin	H315 Causes Skin Irritation
	R41 Risk of Serious Damage to Eyes	H318 Causes Serious Eye Damage
Cement	R37 Irritating to Respiratory System	
	R38 Irritating to Skin	
	R41 Risk of Serious Damage to Eyes	
	R43 May Cause Skin Sensitisation	

Safety

All work shall comply with the relevant legislation and regulations of the statutory authorities concerned. In particular, the Health and Safety Authority's requirements shall be fully observed throughout any work that may be undertaken and comply with:

- The Safety, Health and Welfare Act 2005;
- The Safety, Health and Welfare at work regulations 1993; and
- The Safety, Health and Welfare at work (Construction) Regulations 2006

In order to avoid or reduce risks to health and safety and to ensure that the best practice is implemented, all contractors will provide a comprehensive safety statement. A site specific safety statement and risk assessment must make up part of the general statement. All product safety information is to be available on site and is to be read and fully understood by all personnel assigned to the use of such product.

Operators should wear adequate Personal Protective Clothing and Equipment at all times.


Procedures for disposal of waste and containers should comply with all relevant government, local authority and any other relevant regulations.

Personal Protection

The first step in personal protection is training. This includes making oneself familiar with the material to be used, the associated hazards and the guidance available from the manufacturer / supplier, be it in the form of Safety Data Sheets, direct training or information printed on the bag.

The second step is the correct use of personal protective equipment (PPE). The PPE recommended below is inexpensive and available in many forms to suit individual workers requirements. It is advised that all recommended PPE be worn at all times when handling lime based products, including when opening and disposing of packaging. Table 2 below gives a representation of the PPE required;



	<p>Wear a dust mask</p>
	<p>Use nitrile gloves</p> <p>Wear overalls or long sleeved clothing</p> <p>Wear Safety Boots</p>
	<p>Wear Safety Glasses at all times</p> <p>Wear enclosed goggles when unloading, mixing or applying products, especially quicklime</p> <p>Never wear contact lenses when handling lime</p> <p>Carry a bottle of eye wash such as Diphoterine</p>

First Aid

Following inhalation

Move source of dust or move person to fresh air. Obtain medical attention immediately.

Following skin contact

Carefully and gently brush the contaminated body surfaces in order to remove all traces of product. Wash affected area immediately with plenty of water. Remove contaminated clothing. If necessary seek medical advice.

Following eye contact

Rinse eyes immediately with copious amounts of clean water. If available the preferred option would be to flush eye out with neutralising eyewash capsule (like Diphoterine). Seek medical attention immediately thereafter and do not rub eyes.

BLFI is now recommending that as a precautionary measure, all masons and plasterers working with any mortars and plasters should carry an individual phial of eye-wash on their person. The eye-wash which we have selected is Diphoterine SIEW, which comes in a small holster for attaching to a belt. (It is understood to be the standard issue at all CRH plants). It is manufactured by Prevor, France. www.prevor.com

Following ingestion

Clean mouth with water and drink afterwards plenty of water. Do NOT induce vomiting. Obtain medical attention.

CAUTION:

This document can only be used as a general guide on matters of health and safety regarding the working with lime, transport, its storage and general handling. It is not to be used or in any way interpreted, either in whole or in part, as a Health & Safe Statement. It is based on the best knowledge and advice available at the time of publication. However, no responsibility of any kind for any injury, death, loss, damage or delay however caused resulting from the use of information contained herein can be accepted by the Building Limes Forum Ireland, the authors or others involved in its publication.

At all times a Health & Safety Statement should be prepared and implemented for job specific works and sites.

APPENDIX G: How to tell if a lime mortar was made as a 'Hot-Lime'.

It is accepted that most traditional historic mortars were lime rich, compared to modern practice, with mix ratios as rich as 1 part lime to 1 part sand being relatively common and mixes as rich as 1: 0.25 identified in the analysis of old mortars. It has also been inferred that in hot lime mortars in addition to an excess of lime, there is also an abundance of lime inclusions. However, this on its own cannot conclusively confirm that the mortar was mixed from sand and quicklime, as early putty lime mortars were equally as rich, with an abundance of lime inclusions also present.

It is the difference is in the structure of the inclusions and the form and dispersion of the binder through the mortar that guides the examiner in the identification of the form used.



It is often quoted that if there are an abundance of inclusions within a mortar it is likely that it was mixed as a 'Hot-Lime' where the lime was added to the sand as a Quicklime and that it was used 'Hot'.

This is not necessarily the case as inclusions can also be formed from an accumulation of putty lime, with apparent angular margins formed from the force used in the action of working the mortar and in its placing. It has been recorded in laboratory trials that in comparative mixes made with both putty and quicklime that it was the putty mixes that had the greater abundance of inclusions, reference the *Building Limes in Conservation* (Ian Brocklebank, The Building Limes Forum, Donhead 2012), article by Ewa Sandström Malinowski and Torben Seir Hansen *Hot Lime Mortars in Conservation, Repair and Replastering of the Facades of Läckö Castle*.

It is the shape and the form of the internal fabric of the inclusions that indicate the form in which the binder was used, with this further confirmed by the increased abundance of overburnt, underburnt and unhydrated particles present in hot mixed mortars, compared to putty lime mortars.

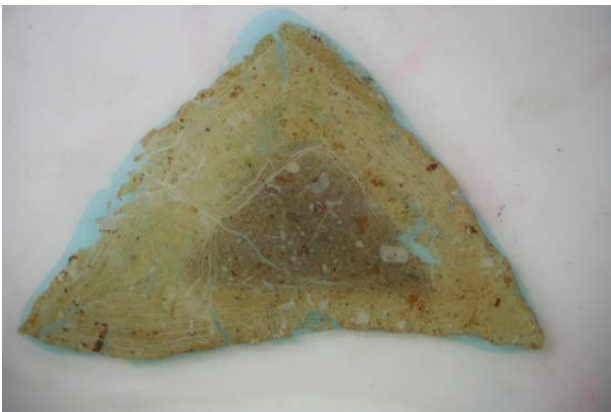
Hot Lime Mortars – Quicklime:Sand mixes

A significant number of the inclusions in a hot lime mortar are angular in shape, or at least sub-angular. Although there will be a large proportion of rounded to irregular shaped inclusions also present from the putty formed by the slaking of the quicklime at the time of mixing.

Examine the inclusions and it should be possible to observe relic rock texture retained within some of the inclusions, and a number of the inclusions will show varying stages of calcining and hydration, this is due to all of the quicklime being added to the mix without separation of partially burnt or overburnt particles, which would commonly be removed by screening (sieving) a putty binder, prior to its use in a mix.

In addition, as the quantity of water added is less than that required to fully hydrate all of the quicklime, there is also commonly an abundance of unhydrated/partially hydrated particles in the mortar.

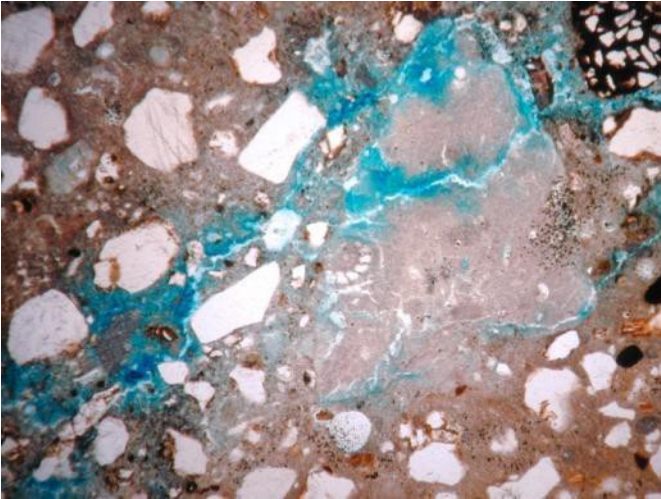
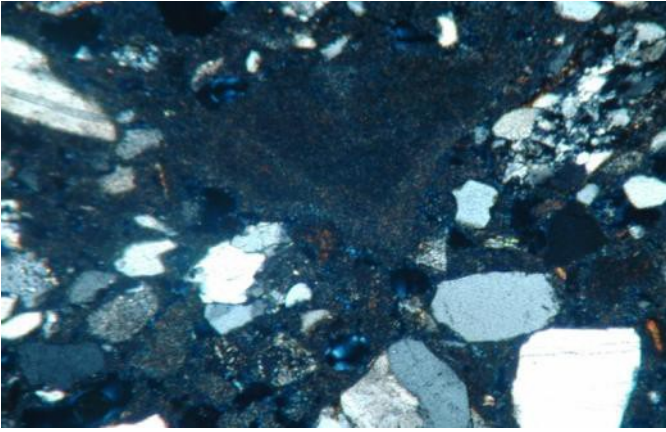
This is also the case where mortars are mixed 'hot', but used 'cold', albeit there tends to be a lower proportion of large inclusions as these are normally screened out of the dry sand/lime mix prior to its use. In addition there is a reduced occurrence of unslaked and partially slaked particles, as these have longer to hydrate during the banking period, and the remixing of the mortar.



An examination of the fabric of the old mortar also usually shows a patchy consistency with areas displaying a high microporosity, which is more common in mortars that have been mixed and used whilst still hot. Hot placed mixes also tend to display a dense margin, and density gradient adjacent to the contact masonry, which is a function of the mortar continuing to expand as it slakes *in situ*. This is often accompanied by an increase in porosity of the paste encapsulating the lime inclusions that were still slaking as placed, as they draw moisture from the surrounding paste.

Some of these features can be seen by the naked eye or with the aid of a hand lens or low power microscope. However, in some instances it is necessary to make a petrographic thin section and examine this in a polarised light microscope to clarify the condition that the mortar was in at the time it was used.

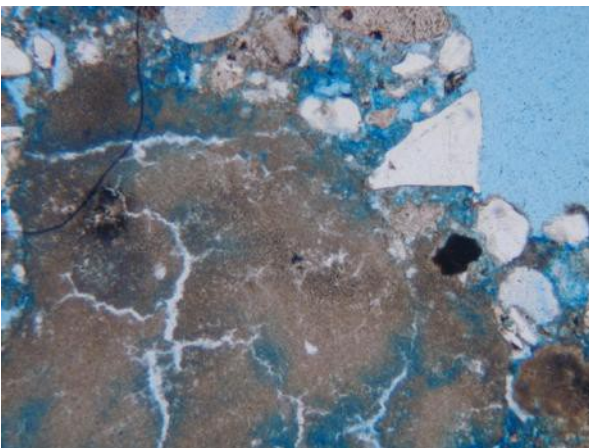
In summary it is the shape and texture of the inclusions and the condition of the paste and presence of perimeter margins, both around the particles and at mortar/masonry interfaces that will guide in the identification of hot lime mortars.



Putty Lime Mortars – Putty: Sand mixes

Some putty lime mortars, particularly binder rich mixes, can present a higher proportion of lime inclusions, compared to quicklime mixes of the same ratio. This can lead to their misidentification. However, the inclusions in putty mixes tend to have more rounded to irregular margins, show flow characteristics which, curve around aggregate particles and fill irregular shaped voids.

Within the core of the inclusions the texture is commonly that of a paste that has undergone shrinkage, displaying typical plastic shrinkage patterns, i.e. concentric that reflect the outer margins, with these intersected by margin perpendicular cracks. Also there is no definite rock texture apparent within the inclusion. Occasionally fine sand grains are incorporated randomly within the inclusion, or concentrated within the outer rim.



As with hot lime mixes variations in binder distribution throughout the mortar can be observed, and areas of dense

paste rich zones are not uncommon, but these are usually free of high microporosity and are commonly transacted by shrinkage cracks and locally by dissolution channel ways.

Putty mixes commonly show plastic flow patterns with the texture of the inclusions lacking a definitive form.

Lime Hydrate Mortars – Hydrate:Sand mixes

This form of mix is not normally encountered in historic stone masonry mortars but can be found in brick masonry where hot mixed mortars used cold in the form of 'sand slaked' mortars is not uncommon. These mixes can have a fabric and texture typical of dry hydrate mixed mortars.

Lime inclusions tend to be rounded and granular, with fine sand/silt coatings, where they have formed putty globules in the mix at time of mixing. These inclusions tend to show a granular to powdery texture throughout with irregular crack patterns, and occasionally with a calcite shell.

The mortars tend to be more uniform throughout their thickness, with a good binder dispersion, unless they have been affected by leaching or chemical attack.

Conclusion

In conclusion it is possible to determine the form in which a lime binder was used, and in some instances it is also possible to establish if the mortar was placed hot.

It requires a little practice and some study of typical examples to enable a practitioner to become confident in their ability to identify the various forms in which lime binders were used. However, it is not difficult to do, but there will always be the requirement to employ more sophisticated examination techniques to confirm which form was used, particularly in leached, weathered and chemically altered mortars.