

**GUIDELINES FOR CONSERVATION  
OF THE BUILT HERITAGE**

**Repair and maintenance of heritage structures  
on the inland waterways of Ireland**

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## ACKNOWLEDGEMENTS

We wish to acknowledge the cooperation of Waterways Ireland staff and especially the great assistance of Eamonn Horgan, Waterways Ireland Environment and Heritage Officer, who acted as liaison throughout and provided support at all stages.

We also thank Patrick McAfee, Grainne Carr and Brigid Tiernan, for their kind permission to use images, and Anna Kealy, for copy-editing the final text.

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# 1 INTRODUCTION

**1.1** This set of guidelines was commissioned in 2015 by Waterways Ireland as one of two documents which aim to address the issue of built heritage conservation in the structures of the navigable waterways and other properties under their remit. This document sets out guidelines for the conservation of the historic built fabric and features of Waterways Ireland. The other document is a report dealing with staff upskilling and training.

**1.2** The guidelines aim to address some of the key objectives and actions of the **Waterways Ireland Heritage Plan 2016–2020**, including:

Action 1–17	Produce policy papers and “best practice guidelines” on heritage topics to ensure consistency of approach along all the inland navigable waterways under our jurisdiction, including: <ul style="list-style-type: none"> <li>• Protection of Archaeology and Built Heritage during maintenance and capital works</li> <li>• A literature review of international heritage best practice relating to inland waterways</li> </ul>
Action 4–11	Investigate the provision of targeted traditional skills training for staff and make spaces open to the public/interested groups, where possible.
Action 4–13	Ensure adequate expertise is available to develop and facilitate the conservation of the waterways heritage resource.

Other actions of the Waterways Ireland Heritage Plan relevant to this topic include: 1.11, 1.13, 3.23, 4.5, 4.12 and 4.14.

**1.3** These guidelines are shaped by the recognition of the existing skills within Waterways Ireland and the identification of where the major deficits lie. They focus on:

- conservation theory as the background to practice
- the approach to be taken to buildings and features of historic value
- the basics of the traditional building and craft skills required
- detailed technical specifications for works relating to masonry repair for in-house staff, but also to allow professional staff prepare tender documentation when engaging external contractors for conservation works

They exclude earthworks, embankments, services, automated systems and health and safety issues.

**1.4** The team appointed to produce both documents is as follows:

**David Kelly**, B.E., C.Eng., F.I.E.I., FConsEI;  
of The David Kelly Partnership, Chartered Engineers, leading practitioners in the field of  
conservation engineering

**Margaret Quinlan**, BArch, MUBC, FRIAI, Accredited Grade 1 in Conservation and  
**Aighleann O'Shaughnessy**, BArch, ex-OPW Senior Architect, National Monuments;  
both of Margaret Quinlan Architects, Accredited Grade 1 practice

## 2 BACKGROUND

**2.1** Waterways Ireland is a North/South Implementation Body established under the British–Irish Agreement of 1999. Waterways Ireland has responsibility for the management, maintenance, development and restoration of inland navigable waterways principally for recreational purposes. The waterways under the remit of the Body are:

- Barrow Navigation
- Erne System
- Grand Canal
- Lower Bann Navigation
- Royal Canal
- Shannon Navigation
- Shannon–Erne Waterway
- sections of the Ulster Canal

The body operates under the overall policy direction of the North/South Ministerial Council. Departmental responsibility rests with the Department of Infrastructure (Northern Ireland) and with the Department of Arts, Heritage and the Gaeltacht (Republic of Ireland).

**2.2** Waterways Ireland manages and operates over 1,000 km of navigable waterways. The functioning of those waterways relies on a myriad of structures and features which form part of the working fabric of the navigations. Many of these features are of heritage value and include locks, lock gates, sluices, weirs, bridges, culverts, quays, jetties, dry docks and mechanical features such as cranes and winches.

Over time, many of these heritage structures require maintenance, repair and general upgrading. It is the responsibility of Waterways Ireland to preserve the heritage fabric of the waterways and its structures, and it is their objective to repair and maintain its structures in a cost-effective manner using conservation best practice.

Currently, repairs to features such as lock gates, locks, sluices, weirs, quays and other navigation stone work, lock ironwork, lock houses and other waterways buildings are carried out by both Waterways Ireland staff and externally contracted staff.

Waterways Ireland sees it as an imperative that the appropriate guidance, capacity and skills to repair and maintain the thousands of structures of heritage value in their care are available within the organisation.

**2.3** Tasks and functions relating to the built fabric of the Waterways system include:

- Routine maintenance and small repairs to locks and lock houses
- Routine maintenance and small repairs to quay, harbour and lock walls
- Repairs to other masonry items such as slipways and navigational markers
- Medium- to large-scale projects, some cyclical, such as lock gate replacement and the building, repair or rebuilding of walls, weirs and breakwaters
- New developments, such as hard edge moorings, new cycle/walkways, jetties, canoe step landings, railings etc.
- New buildings or facilities in the curtilage of protected or listed structures
- Larger-scale building conservation projects such as lock houses or other structures of historic merit, including protected structures
- Ongoing maintenance around the curtilage of structures, including painting, grass cutting, cleaning, vegetation clearing, and hedge cutting

Some of the project types listed above may have actions to improve safety included in the works.

### 3 METHODOLOGY

**3.1** A series of meetings was set up by Waterways Ireland to give an initial briefing from each of the regions. As part of the meetings itinerary, arrangements were made for the team to visit a cross-section of Waterways Ireland sites, representing a range of operational repair and construction activity. The site visits informed the assessment necessary for the Upskilling Report and also provided valuable background information for these Conservation Guidelines.

**3.2** Meetings were held in the following locations:

- Dublin Office: Ashtown Gate
- Rooskey
- Tarmonbarry
- Portumna
- Enniskillen Head Office

An additional meeting was held with Michael Donovan, Safety Advisor, to discuss the Waterways Ireland Health and Safety regime and any impact upskilling in conservation techniques might have.

**3.3** The following sites were visited in the company of Waterways Ireland staff:

- Royal Canal: 2nd, 3rd, 4th and 5th locks
- Rooskey
- Clondra
- Richmond Harbour
- Tarmonbarry
- Shannon Harbour
- Killaloe
- Enniskillen Archives
- Tullamore workshop and harbour



- 3.4** The guidelines were prepared based on the team's knowledge and experience of the field of conservation. Much valuable information came from Waterways Ireland briefings and from the specific issues identified and discussed at our series of site visits and meetings with Waterways staff.

From these briefings for this document and the Upskilling and Training Report, it was clear that the knowledge and expertise for specialist works relating to the waterways and the necessary carpentry skills exist within the organisation, and the challenge lies in transmitting these before experienced staff retire. The major deficit in applied skills lies in the repair and conservation of masonry, including the use of lime, and this is reflected in this document.

## 4 TAKING THE CONSERVATION APPROACH

Waterways Ireland, as a body managing public assets, is fully committed to properly maintaining and managing the heritage structures in its care.

In order to do this effectively, it is essential that the entire staff, from management to operational level, take the correct approach in dealing with these buildings and features. Taking a conservation approach often means changing how we see buildings or think about them. If we look at something that is over 200 years old and consider how we can best look after it in our time so that others can appreciate it another 200 years from now, we see it and think of it in a different way.

To change our mindset and our approach, we need:

- a knowledge of the history and significance of the structure
- an awareness of legislative protection and of the international codes and charters on which it is based
- a knowledge and full acceptance of the principles of good practice

Waterways Ireland fully supports its staff in achieving this and in undertaking all necessary training in order to implement good practice.

### 4.1 HISTORY AND SIGNIFICANCE

Normally, extensive research is required to establish history and significance. However, Waterways Ireland (WI), conscious of its legacy and its commitments, has built up a significant collection of information on the heritage structures in its care, including:

- WI Bridge Management System
- WI Built Heritage Surveys
- WI Condition Reports
- WI Archives

In addition, there are the listings in: the National Inventory of Architectural Heritage (NIAH); the Record of Protected Structures (RPS) for each local authority; the Sites and Monuments Record (SMR), the national database for monuments; the Northern Ireland Buildings Database; and the Northern Ireland Monuments and Buildings Record.

From this material can be prepared a dossier for each building or feature that will detail its history and significance and serve as the necessary background information for technical and operational staff. The dossier will also give an outline of condition and a history of previous repairs, where known. It will become the source of information for all aspects of the building or feature. It will also become the building logbook – the record of all interventions – and will be an invaluable resource for management of the built fabric

of the waterways. Initially, those buildings or features about to undergo repairs or improvements can be prioritised for the creation of dossiers.

## 4.2 LEGISLATIVE PROTECTION IN THE REPUBLIC OF IRELAND

### Categories

- National Monuments
- Protected Structures
- Architectural Conservation Areas

### National Monuments

Most of the navigation system was constructed post-1700 and, therefore, associated structures fall outside the usual – but not definitive – pre-1700 dating category for national monuments. However, many recorded monuments exist within navigable rivers. These include: ancient fording sites; crannógs; sites of former bridges; and some pre-1700 bridges and weirs constructed on the sites of older weirs, or of historic fording places. Work which impinges on any of those National Monument sites, together with works which may fall within the constraint areas of National Monuments located close to the navigable waterways system or its ancillary buildings, is governed by the National Monuments Acts 1930–2004, together with the accompanying regulations.

In the case of works which impinge on a National Monument, ministerial notification will be required. Where work to an existing structure is to be undertaken within the constraint area of the National Monument, the National Monuments Advisory Service should be notified formally in the first instance. As an outcome of the notification, further consultation and/or archaeological supervision may be required. The historic environment database, [www.archaeology.ie](http://www.archaeology.ie) – a website of the Department of Arts, Heritage and the Gaeltacht – shows the location of National and Recorded Monuments as a series of red dots which may be interrogated.

### Protected Structures

Each local authority has compiled and maintains a list of designated Record of Protected Structures (RPS) as part of its Development Plan.

Virtually all canals, overbridges, aqueducts and ancillary buildings are listed in the National Inventory of Architectural Heritage (NIAH). Any that are not already listed in the Record of Protected Structures may become Proposed Protected Structures by virtue of this NIAH listing. The mapping system on [www.archaeology.ie](http://www.archaeology.ie) mentioned under the previous heading shows NIAH listings as a series of blue dots.

The Planning & Development Acts 2000–2011 govern all works to protected structures which fall outside the normal range of “Exempted Development” set out in Section 4 of the Planning Act, but have a separate set of definitions set out in Section 57 as follows:

*Works affecting character of protected structures or proposed protected structures:*

*1) Notwithstanding Section 4 of the Planning Act and any regulations made under that section, the carrying out of works to a protected structure or a proposed protected structure shall be exempted development only if those works would not materially affect the character of –*

*(a) the structure, or*

*(b) any element of the structure which contributes to its special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest.*

*1) An owner or occupier of a protected structure may make a written request to the planning authority, within whose functional area that structure is situated, to issue a declaration as to the type of works which it considers would or would not materially affect the character of the structure, or any element, referred to in sub-section (1)(b), of that structure.*

There is also the option of applying for a Section 5 Declaration under which an owner can seek an exemption for a specific action or works. Section 5 is not confined to protected structures.

### **Architectural Conservation Areas**

Buildings or structures situated within an Architectural Conservation Area, as defined in a Development Plan of a Planning Authority, are covered by Section 82 of the Planning Act as follows:

*Development in Architectural Conservation Areas*

*1) Notwithstanding Section 4 of the Planning Act or any regulations made under that section, the carrying out of works to the exterior of a structure located in an Architectural Conservation Area shall be exempted development only if those works would not materially affect the character of the area.*

*2) In considering an application for permission for development in relation to land situated in an Architectural Conservation Area, the Planning Authority, or the Board on Appeal, shall take into account the material effect (if any) that the proposed development would be likely to have on the character of the Architectural Conservation Area.*

### 4.3 LEGISLATIVE PROTECTION IN NORTHERN IRELAND

#### Categories

- Scheduled Monument
- Listed Building, Grade A, B+, B1 and B2.

#### Scheduled Monuments

Work to a historic monument in Northern Ireland is governed by the Historic Monuments and Archaeological Objects (Northern Ireland) Order 1995. Work to a scheduled monument or in an archaeological area may proceed only following Scheduled Monument Consent, which may be granted as set out in the above legislation by the Department of the Environment (Northern Ireland).

#### Listed Buildings

Listed buildings in Northern Ireland are graded thus:

Grade A: Special buildings of national importance

Grade B +: Buildings of similar quality to Grade A but which may have been altered or have lower quality additions

Grades B1, B2: Special buildings of more local importance

The following is the advice from the Northern Ireland Environment Agency:

You are required to obtain Listed Building Consent from the Planning Service if you propose to carry out repairs, alterations or demolition, or to construct an extension which affect the character of a listed building inside or out. Changes which may seem minor to you may have a major impact on the building's character, for example, the replacement of timber windows.

*Planning Policy Statement 6: Planning Archaeology and Built Heritage* explains what can be done to a listed building. *Planning Policy Statement 6*, however, provides very little additional advice other than the criteria in a general way. However, it would appear that the Listing Notice should contain the criteria for listing under a number of headings, which may be useful in determining whether any proposed works would be such as to affect the character of the listed building.

Listed Building Consent must be applied for in accordance with the Planning (Listed Building) Regulations (Northern Ireland) 2015.

#### 4.4 INTERNATIONAL CODES AND CHARTERS – The Basis of Government Guidelines See Appendix 1 for a detailed account

There are international codes which govern the conservation approach to be taken to historic buildings, and governments have incorporated such codes into national legislation. Those with responsibility for decision-making should be aware of this background.

The international documents governing the conservation of heritage are of two kinds: Conventions and Charters. The principal difference is that ratification of international Conventions carries with it the obligation to incorporate its provisions into national legislation. Conservation Charters are statements of principle and do not have the force of law. Their provisions are, however, frequently reflected in national legislation.

Ireland and the United Kingdom have ratified two such Conventions – the UN World Heritage Convention (1972) and the Convention for the Protection of the Architectural Heritage of Europe (1985). Provisions of these Conventions have been incorporated into legislation.

The Charters are generally short and concise and have been produced from 1963 to the present time. The best known are probably the Venice and the Burra Charters. Access to the full range of ICOMOS charters can be had through [www.icomos.org](http://www.icomos.org). Access to their contents is greatly helped by guides such as *The Historic Scotland Guide to International Conservation Charters*.

Note: Technical guidelines produced by national governments are based on the Charters.

In the Republic, the Department of Arts, Heritage and the Gaeltacht publishes the *Advice Series* of guidance documents, relating to a wide range of conservation areas. These can be accessed at: [www.ahg.gov.ie/heritage-publications](http://www.ahg.gov.ie/heritage-publications). Also on this website can be found the publication *Architectural Heritage Protection: Guidelines for Planning Authorities* (2007), which provides clear summaries of the principles of conservation of architectural conservation and sets out the provisions of the relevant Irish planning legislation.

In Northern Ireland, guidance documents can be found on the Northern Ireland Environment Agency and Department of Communities websites [www.doeni.gov.uk](http://www.doeni.gov.uk) and [www.communities-ni.gov.uk](http://www.communities-ni.gov.uk).

Historic England and Historic Environment Scotland both publish a wide range of guidance on their websites <https://historicengland.org.uk/advice/technical-advice> and <https://www.historicenvironment.scot/archives-and-research/publications>

All such government-sponsored guidance can be taken as being in compliance with the Charters especially in relation to routine work. However, when less usual circumstances

arise or projects have complex issues, direct recourse to the Charters and interpretation of them may be necessary.

**A fuller account of the charters and conventions and how our legislation derived from them is given in Appendix I.**

#### 4.5 PRINCIPLES OF GOOD PRACTICE IN CONSERVATION

The principles may be summarised as follows:

- The **first** principle is to undertake only such work as is necessary to maintain the structure, continue it in use, and prevent deterioration. This is generally referred to as “minimal intervention”.
- The **second** principle is to employ only those materials and techniques as are compatible with the original construction and the materials used in it.
- The **third** principle is that all previous actions may have authenticity. So before deciding to restore any structure to an earlier state, there should be a careful examination of the consequences of the disturbance caused by such an action, whether such action would provide a long-term benefit for the structure, and an assessment of the historical context in which later interventions were carried out.
- The **fourth** principle is that all work should be preceded by careful examination and survey and recording, including photographic recording and a careful assessment of the options.
- The **fifth** principle is that any intervention undertaken to ensure long-term stability and/or the safety of users should be such that it can be reversed in the future should that prove necessary. This is generally referred to as “reversibility”.

## 5 SCOPE OF CONSERVATION WORKS

### 5.1 THE STRUCTURES AND THE RANGE OF CONSERVATION WORKS

**Waterways Ireland structures** include the following:

River and canal lock structures and gates

Quays, harbour walls and landing places

Dry docks and other boat docks

Bridges, aqueducts

Culverts, overflows, by-pass channels, syphons

Weirs

Navigation markers

Buildings of significance

- lock-keepers' houses
- canal company houses
- warehouses
- ruins of hotels, warehouses, etc.
- maintenance depots with all their ancillary equipment

The **actions and works** covered by this document include maintenance, repair of wear and tear including erosion, repair of leaks, repair of damage and alterations to the above structures.

The principal **materials and trades** involved are stone and masonry including brick, timber and carpentry, ironwork and whole building maintenance.

Some **specialist services** such as the cutting and finishing of replacement stone and the repair of original wrought and cast iron is probably best carried out by external suppliers. The **fitting** of such components can be carried out by Waterways Ireland.

There are many other actions carried out by Waterways Ireland which are outside the scope of this document. These include repair of banks and bank slippages, repair of lifting and hydraulic equipment, retrofitting hydraulic mechanisms and automation.

### 5.2 NECESSARY PERMISSIONS AND CONSENTS AND AGREEING WORKS WHICH ARE EXEMPT

The legislative protection regime for the many heritage structures on the navigable waterways is set out in the previous chapter at Sections 4.2 and 4.3.

The essence of the legislative protection is that nothing should be done to a structure that affects its character or the character of any element that contributes to its significance. Planning permission or consent must be sought for any works which could affect its character or significance. Repair and general maintenance which does



not affect the character of a listed building or a protected structure is generally exempt from consent requirements.

It is important to note that in the case of protected structures, the legislation does not allow for granting of permission for the retention of **unauthorised works**.

Deciding which works require permission or consent or which are exempt can be difficult and is an issue which requires knowledge and experience. For example, the following actions would affect character:

- replacing a timber window in pvc or aluminium
- changing the window pattern or pane size, replacing original glass with double glazed units
- re-roofing with man-made slates or concrete tiles
- replacing a traditional corrugated sinusoidal metal roof with modern metal decking
- taking down a disused chimney
- replacing a wrought-iron land anchor with a rectangular steel plate bolted down over the stone
- new render or repointing to a building

The following would not affect character:

- replacing a decayed timber window sash with an exact match/repairing a roof with slates to match the existing roof
- replacing a wrought-iron land anchor with steel plate made to fit the existing profile cut in the stone
- patching render to match the existing material and finish

**5.3** The **best course of action** is to consult with the planning authority. Usually the Architectural Conservation Officer, or the official acting in this role, will advise. There can be some variation in approach by the planning authorities so do not make any assumptions based on a single response. The standard procedure in the Republic is to apply for a Section 57 Declaration which will set out which works require permission and which works are exempt on a case-by-case basis.

**Routine maintenance and minor repair** does not normally require planning permission in the Republic of Ireland or Consent under Listed Building Regulations for Northern Ireland. A body such as Waterways Ireland, with so many properties, could make a formal approach to all planning authorities in whose areas the navigable waterways lie, with the aim of simplifying the consultation process and clarifying works which are exempt.

These **Guidelines** may, if accepted by the planning authorities, serve a useful purpose in setting protocols and standards for works thereby making some application for Declarations unnecessary and clarifying the whole process for Waterways management. An agreement could be reached with the planning authorities on a **list of**

**actions and their methodologies** which may be undertaken without further reference to the control authority on condition that they are carried out in compliance with the agreed standards.

**5.4** The following indicative list is suggested as possible headings for drawing up a list of actions for agreement:

- **Repair of wear and tear** includes replacement of items which have worn out in their use. Within locks, that may include lock gate repair, paddles, occasionally rack and pinions or windlass handles, guard rails, etc. and painting schemes. On buildings, it will include repairs to joinery, glazing, roofs and rainwater goods as well as changes to painting schemes for cottages and houses.
- **Repair of damage** will, inevitably, fall into more than one category. The repair of minor damage could be incorporated into an agreement on wear and tear as outlined above. More significant damage such as impact damage to stone may require a separate Declaration or Consent. If regarded as exempt, the conservation officer may still advise on the finish or tooling on the stone.
- **Repair of leaks** may be minor or major works. Some, especially on the canal system, may be regarded as emergency works where any delay is critical.
- **Emergency repairs** should have contingency plans agreed in advance with the control authorities as part of a general Declaration or Consent.
- **Control of vegetation** on buildings and masonry will be an ongoing maintenance action. It will certainly bring with it the need for minor repairs such as patch repointing or render repair.
- **Alterations**, such as the replacement of lock gates, the renewal of wooden landing stages, etc. will almost always require a Consent or Planning Permission, as would re-roofing of cottages or other buildings, or significant repair or large-scale replacement of windows and doors, repointing or re-rendering the exterior. Minor alterations may be incorporated in an agreed list of actions.

**5.5** Generally, it is always advisable to **notify the planning authority** via the conservation officer when proposed works start even if they are exempt. Members of the public have become increasingly vigilant and walkers along the waterways may report works being undertaken. This adds unnecessarily to workload within the planning authority and can be avoided by the simple courtesy of notification.

## 6 PREPARING FOR WORKS

- 6.1** The preparation of a **dossier** for each site is essential. All information – both historical and more recent interventions – will be contained in a compact form and will serve as the starting point for any works.
- 6.2** Prepare a **work sheet** for the proposed action detailing the reason for the work and what is to be done. Add to the dossier.
- 6.3** Check if the proposed works are **exempt** and obtain **permission or consent**, if required.
- 6.4** **Make a record** of the project by photography and by dimensioned annotated sketch as appropriate. When preparing to undertake significant works to any structure, it is essential to acquire an understanding of the form of construction and the materials used in it. Original construction drawings are the best starting point, together with any record of later interventions and/or repairs. Where no drawings of a particular structure survive, other similar works by the same engineer or builder may provide a clue to the form of construction. The historical information, together with the survey and photographic record (preserve in paper form and add to the dossier) should form the basis for the methodology and specification.
- 6.5** Where failure of a retaining structure, arch, aqueduct or culvert requires action, then additional exploratory investigation may be necessary to determine the **exact cause** of the failure.
- 6.6** Where the work involves the conservation of an entire structure, then a **small trial** of the method to be employed can be useful in proving the method and serve as a pilot for the remainder of the work. It is also useful in terms of consulting with the planning authority.
- 6.7** Assessments of accidental damage and/or vandalism should be prepared with a view to **reducing that risk** in the future. A clear statement of the causes and consequences of the damage can be useful in designing preventative measures and should be kept as part of the conservation history of the structure.
- 6.8** Prepare the **detailed methodology** and specification.
- 6.9** Remember to allow sufficient time to deal with removal of **vegetation**, where necessary, before works commence. Usually, well-established vegetation will require treatment (by a substance to be approved by Waterways Environmental section) and must die off before removal.

## 7 STONE AND MASONRY REPAIR

### Refer to Appendix III: Technical Specifications

- 7.1 One of the principal elements in this section is the **choice and use of mortars**. Mortar is a mix of sand and a setting agent, used in jointing and pointing stone and brick, in renders and plasters.

Choosing the correct mortar, with its components of setting agent and sand, will vary in accordance with the material being jointed and the environment in which it is being used. The precise choice of mortar for an application requires knowledge and experience.

- 7.2 The **setting agents** used in mortars are cement and lime. A clear distinction must be drawn between them. Most professionals and operatives are familiar only with the use of cement as a setting agent when working on masonry. **Cement is most unsuitable** for use in jointing and pointing in historic masonry as it is hard, impermeable and prone to shrinkage. Its lack of flexibility does not accommodate the small movements that take place in traditional construction. Its impermeability does not allow structures to breathe. Cement can cause significant damage to stone, brick and to historic structures in general.

**Lime** is far superior as a setting agent in this context. Available in a variety of forms, it is an essential material in the conservation and repair of masonry structures. It is the setting agent referred to for all mortars, renders and plasters in this document. It is an important principle that the mortar which binds structures together must be softer than the stone or brick in order to absorb and release moisture thus protecting the stone. Lime mortar acts in this way. It is also self-healing in that it can seal hairline cracks which have opened.

Working with lime requires knowledge, skill and a different approach to setting time and protection of the work in progress or the completed work. A short, hands-on course in the use of lime is the most effective introduction and should be undertaken before its initial use. Operatives can take more advanced courses as they become familiar with its application. Lime mortar is a far more pleasant material to use than the cement-based alternative and it becomes the material of choice for most operatives.

- 7.3 Working **above or below water** requires great care. The aquatic environment may require that the vegetation is treated by painting onto the leaves or, where heavy stemmed types are involved, it may be possible to drill the stem and fit a short pipe of the chemical which can then be capped and sealed. Waterways Ireland Environment Section is its own expert in this area and should have an approved list of products for

treatment of vegetation in aquatic environments as well as general methodologies for working around water.

#### 7.4 REPOINTING – GENERAL PRINCIPLES

Repointing will be necessary at some stage for all masonry elements on the navigable waterways, especially where the feature is very exposed or disrupted by vegetation. Waterways Ireland will plan ahead for this in its programming of maintenance works.

The durability of the new pointing depends to a great extent on the **choice of mortar** and the thoroughness of the **preparation**. It is essential that all **vegetation** is removed, together with the humus that supports it, followed by the removal of all decayed mortar. Failure to fully remove the humus – a rich and fertile organic matter created by decayed vegetation – leads to regrowth. Vegetation needs to be treated with a Waterways Ireland approved weed or brush wood killer sufficiently well in advance of the repointing work to allow time for the chemicals to reach the root system of the vegetation involved. The dead vegetation may then be raked out together with any accumulated humus and the joint well flushed.



A canal lock wing wall showing the full range of vegetation - aquatic plants, moss, ivy and self-seeded sycamores. Note the number of joints that are empty of mortar

**Decayed and loose mortar** should then be raked out to a depth of at least two-and-a-half times the thickness of the joint. Then, at least a day in advance of pointing, the joints should once more be flushed with clean water. It is essential that there is **no standing water** within the joint which would reduce the effectiveness of the repointing mortar.

The **new mortar** must be placed to sufficient depth and compactness to ensure that no water will be retained on any of the interfaces, which would lead to damage by frost and/or re-colonisation by vegetation. The insertion of the new mortar must be done in stages or layers in order to achieve proper compaction. The layers should be 20mm maximum and must be well rammed home with a wide lath or a purpose made ramming tool to compact the material. See below (Sections 7.5, 7.8) for finishing of the joint.

## WALLS IN CONTACT WITH WATER

### 7.5 REPOINTING LOCK, HARBOUR AND QUAY WALLS

Lock, harbour and quay walls – whether built of block in course, ashlar or regular coursed squared rubble or brick – function similarly and should be treated in the same way. Because they are built in courses using regular, squared stone, some of the joints can be very fine and regular plugging chisels for raking out may be too thick. Tools for raking out may need to be made specifically for the job. A hacksaw blade set in a wooden handle is a common solution to this problem.



**Block in course**  
Used in walls built for strength. Stones are deeper than usual. Stones shorter on the face are long stones running back into the depth of the wall



**Ashlar**  
Regular squared fine-jointed work which looks similar to Block-in-course but stones are not as deep

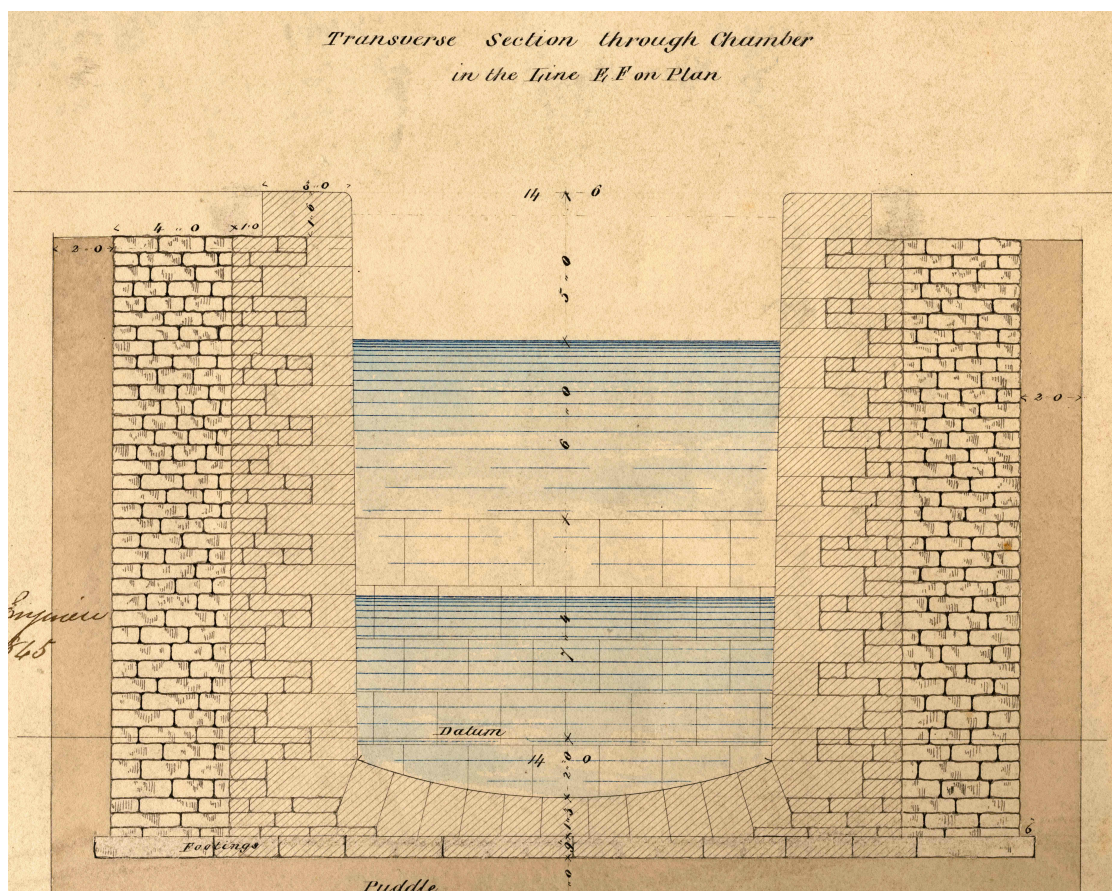
As these walls are in contact with water, in addition to removal of vegetation as described above, the works may need to be preceded by a careful cleaning and removal of aquatic vegetation and moss. This process may involve some deep scraping out of the joints. Decayed mortar and loose mortar should then be raked out to a depth of at least two-and-a-half times the thickness of the joint. The joints should then once more be flushed with clean water, at least a day in advance of pointing. It is essential that there is **no standing water** within the joint which would reduce the effectiveness of the repointing mortar.

All joints so filled, whether horizontal or vertical, should be finished flush with the face of the masonry until it has become firm to touch, at which time it shall be **compacted or 'struck'** with a rounded tool firmly pressed to create a slightly concave finish to the joint. This final striking of the joint is intended to ensure good compaction and water

tightness. Please note that the rounded tool achieves a better compaction for this type of masonry with finer joints and will be different to that used for rubble walls.

Mortar for repointing in this situation will generally be made with NHL5 (Natural Hydraulic Lime 5) in accordance with the specification. However, work in the splash zone may be subject to premature wetting and therefore the mortar used in that zone may incorporate up to 10 per cent of Prompt (a patent setting agent made from a type of limestone; see Appendix III, Technical Specifications) to produce an early set.

Where the joints have collapsed due to erosion of the mortar, then injection grouting may be the only solution to protecting the masonry in depth.



A drawing from Waterways Ireland Archives dated 1845 showing the construction of a lock built of 'block in course' backed up by squared masonry and sealed with puddle clay

## 7.6 MASONRY NAVIGATION MARKERS

The masonry beacons are also in contact with water and are generally constructed either of random rubble or squared rubble (possibly built on rubble mound foundations). Repointing, generally, should be carried out when the rivers and lakes are at their lowest level. Vegetation, including aquatic vegetation must, be carefully cleaned and removed as in Section 7.5. This process may involve some deep scraping out of the joints, taking great care to retain the pinning or packing stones used in rubble walls, which will be dislodged during the cleaning process.



Squared rubble



Random rubble limewashed



Ashlar on random rubble mound

Repointing will follow the procedure set out in the Section 7.5 above for squared, coursed masonry or in Section 7.7 below for rubble masonry. The difference between the two lies in the pinning and packing stones and joint thickness.

Mortar for repointing will generally be made with NHL (Natural Hydraulic Lime) 5, in accordance with the specification. However, work in the splash zone may be subject to premature wetting and therefore the mortar used in that zone may incorporate up to 10% of Prompt (see Appendix II: Glossary) to produce an early set.

## 7.7 WORK BELOW THE WATER LINE

Work below the water line, which will require qualified divers experienced in repointing work, may be carried out using the same specification. Placing of the pointed mortar will require the use of a pointing gun, with a long nozzle, to facilitate the placement of the mortar without mixing it with the surrounding water. A floating skirt or silt curtain will be required to contain accidental spills.

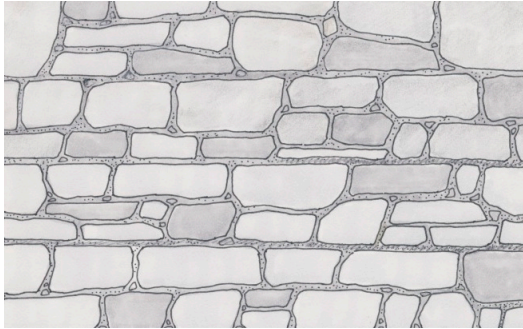
Grouting, should it be necessary, will follow the same procedure as set out in the section on grouting at Section 7.10. The below-water level work will require the grout tubes to be extended above water level and grouting will have to commence at the very base of the structure, so as to displace the contained water upwards. The grout used below water level will also have to contain Prompt to achieve an early set.

Beacons with iron or steel finials have an additional maintenance requirement. Where the iron or steel is to be repainted in situ, then the manual preparation and painting should be carried out as in Section 10.3, on Paint Systems for Metal.

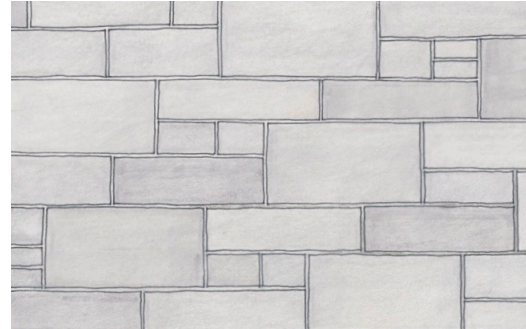


**7.8 WALLS NOT IN CONTACT WITH WATER**

Walls not in contact with water (such as boundary walls, walls of buildings and parapet walls of bridges made of **ashlar, regular coursed squared rubble or brick, squared rubble built to courses, uncoursed squared or snecked rubble**) should be repointed as described above but using mortar made with NHL 3.5 for stone generally and NHL 2 for brick or soft stone, in accordance with the specification.



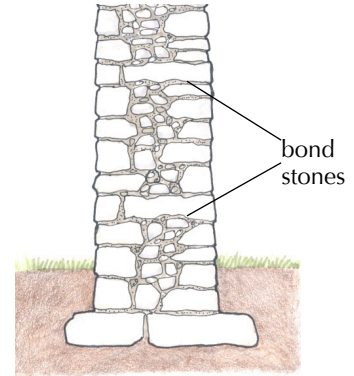
Coursed rubble



Snecked squared masonry

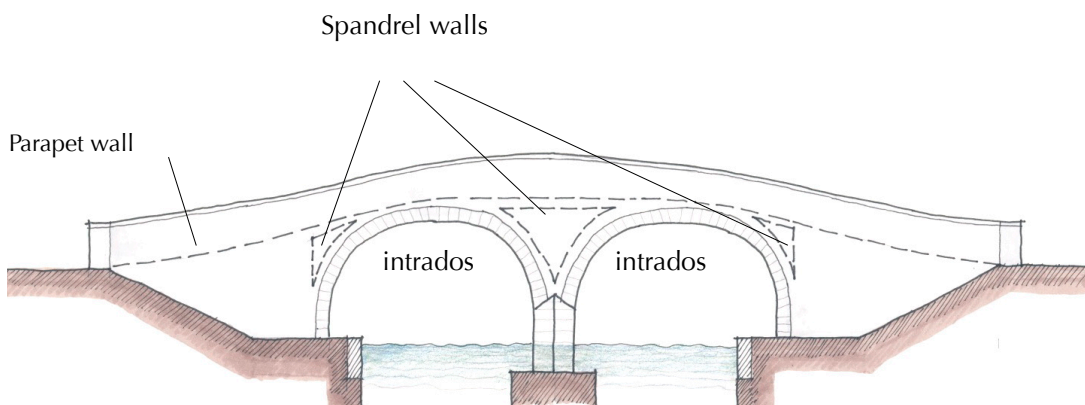


Random rubble with quoins or corner stones on right



Cross section through rubble wall

**Bridge spandrel walls, voussoirs and intrados** built of regularly shaped stone, as described above, should generally be repointed as described above, but using mortar made with NHL 5.



**Random rubble** uncoursed walls, as well as **coursed random rubble** in boundary walls, parapet walls of bridges, buildings of lesser quality and ruins (originally rendered but now with exposed stonework) shall be prepared and raked out as described for lock walls. In addition, pinning or packing stones dislodged during the raking process shall be retained for re-insertion. A cover sheet on the ground at the base of the wall will facilitate collection. The mortar which has been raked out shall also be retained, washed and sieved for grading, so that the pointing mortar may match the original including the size, shape and quantity of grit incorporated. The finished mortar joints should be in the range of 12–18mm face thickness, with a preference for trying to achieve the average of 15mm by inserting pinning stones into the larger joints. Small pieces of natural slate are also useful in reducing joint thickness along bed joints. The much larger voids that can occur where the corners of two roughly shaped stones meet will be filled by a larger pinning stone, bearing in mind that the joint will have to be raked out to a greater depth to ensure that the pinning stone is firmly bedded.

The purpose of controlling the face thickness of the mortar joints is to reduce shrinkage and thus ensure that the pointing mortar remains in tight contact with all interfaces. The finished joint should then be struck level with the face of the stonework. Well-compacted mortar is essential for the durability of the pointing and so, when the joint has become firm to touch, it should be beaten back using a narrow, stiff-bristle brush which will have the effect of further tightening the mortar into the joint and will also expose the coarser aggregate in the mortar, helping it to blend with the areas which may not have been repointed.



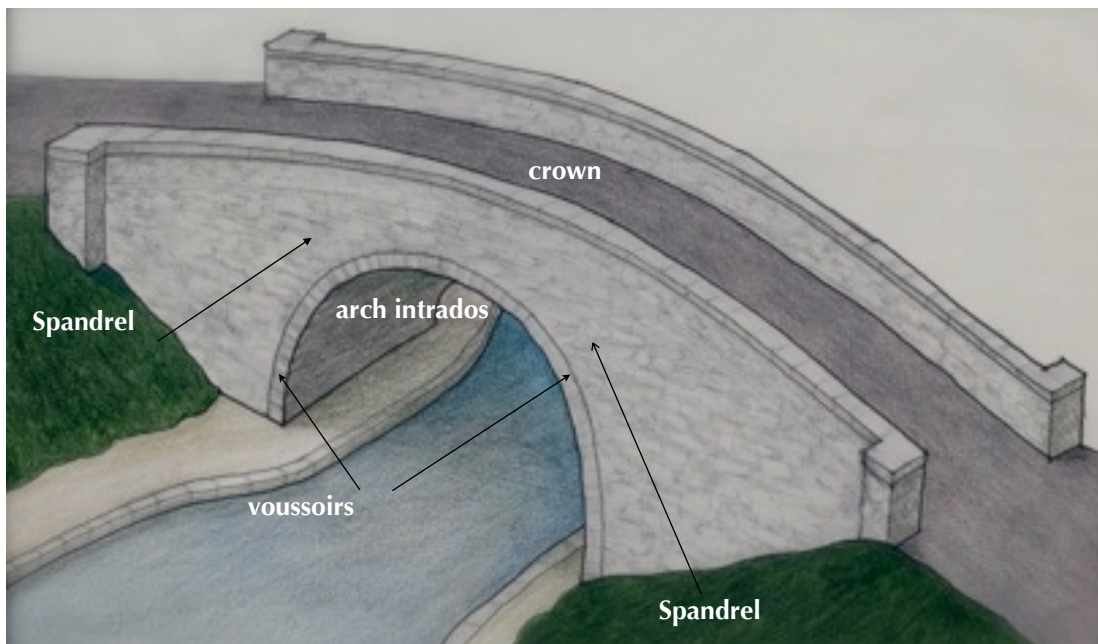
Rubble wall-top flaunched to allow water to run off as described at 7.9

### 7.9 RUBBLE WALL TOPS

The tops of rubble-built walls which have not been provided with dressed stone copings need protection to prevent water penetration into the core of the wall. This is achieved by a process called flaunching. The exposed masonry at the top of the wall is cleaned as described for repointing, but where there has been heavy accumulation of vegetation and humus, the stones may also require re-bedding. When fully cleaned, the masonry at the top of the wall is repointed or, as needs be, re-bedded, but instead of striking all of the pointing level with the surface of the masonry, it is formed so as to provide drainage channels to the outside faces of the wall. It is important to understand that large build-up of mortar or the creation of a cobbled effect by setting small stones in mortar is not effective in the long term, but the careful creation of drainage paths will prevent premature breakdown of the wall top.

### 7.10 BRIDGES

Bridges are now subjected to traffic loadings of a magnitude unimaginable at the time when the bridges were built. At the time of construction, loading from traffic was insignificant compared to the weight of the structure; however, trucks with up to the fully permitted axle loadings are free to use even the most minor of rural roads, with only very rare exceptions. The effect of these forces, both vertical and horizontal, is to distort the shape of the arch, causing failure in the mortar followed by displacement of the voussoirs. Assessment of the waterways bridges for modern traffic loading is not part of this handbook. However, routine inspection should include careful examination of the arch intrados for signs of displacement of voussoirs and for cracks at right angles to the span of the bridge, together with signs of outward rotation of spandrel walls.



Should a bridge have a loading restriction applied to it following analysis, then repairs can be carried out generally, as already described, but may also include the need to tie

the spandrel walls together from side to side and to expose the crown of the arch to facilitate re-setting, repointing and/or regrouting to restore continuity. The protection of the arch from water penetration from the carriageway should also form part of the reinstatement.

### **7.11 AQUEDUCTS**

Aqueducts have static and unchanging loading, except when the canal is drained. The normal purpose of an aqueduct is to carry the canal over a local river or stream or a deep valley. Apart from normal wear and tear, the two significant risks to an aqueduct are from scour to the bridge piers and abutments from the local river and/or leaks in the lining of the canal.

As with bridges, regular inspection and routine maintenance are essential for these structures. The risk of scour is increased where debris is permitted to accumulate against the cut waters of the bridge structure, but all serious flood events should be a trigger for inspection for scour.

The intrados of the bridge arches and the spandrels of the bridge should be inspected during dry season for signs of seeps from the canal overhead.

The repair of scour damage does not form part of this document, as the work is specialist with expert knowledge within Waterways Ireland. Similarly, Waterways staff are experienced in canal lining and the use of puddle clay.

The specification for routine maintenance, however, should follow the same guidance as given above.

### **7.12 GROUTING**

Grouting is the introduction of a free-flowing, mortar-like material, using pipes or tubing, into the core of a wall behind the face. The purpose of grouting is to improve the bond between the face masonry and the wall core or backing masonry. It is best introduced from the face, using the joints in the masonry as the access to the core. It will often be necessary to drill along the joint into the core area but only in the soft material such as mortar. Drilling into solid masonry is of no value. The grouting pipe is then set in the joint as pointing progresses, generally at approximately one-metre centres horizontally and vertically. Grout, in accordance with the specification, is then introduced, either by gravity feed or by hand-operated pump, starting from the bottom and filling until the next grout pipe shows signs of grout and so progressing along horizontally and vertically and, preferably, in a continuous operation.

The grout mix will depend on the thickness of the joint through which it has to be fed and may either be a pure lime grout with an intrusion aid or grout with some very fine sand added. Grout is not intended to fill large voids, since its high moisture content makes it subject to shrinkage. By grouting from the face it is also possible to fill eroded bed joints where the loss of mortar has reduced the joint size so as to make it

impossible to point. In that case, temporary caulking will have to be provided to seal the face of the joint in order to contain the grout.

Grouting in rubble masonry follows the same procedure. However, because the joints tend to be larger, the grout will almost always be a sanded grout and (preferably) applied by gravity.

Grouting the intrados of masonry bridges will inevitably have to be done using a hand pump, since gravity grouting will be difficult due to the long lengths of feed tube required.

When grouting soil-retaining structures, it must be understood that masonry grouting cannot deal with inflows of water from the soil being retained. Grouting to prevent water penetration from behind a retaining wall can only be effective by installing a grout curtain behind the wall using a heavy mud such as Bentonite, not to be confused with puddle clay.

### 7.13 CRACK AND STONE REPAIR

Crack repair is normally undertaken after repointing and grouting is completed. Repairs to cracks caused by foundation movement is of little effect without dealing with the cause of the cracking. Crack repair following accidental damage, or from wedging by roots of vegetation, is worth undertaking primarily to restore the bond between the two sides of the crack. The crack should be mortar-packed and pointed, as generally described for repointing. The two sides of the crack are then reconnected by drilling through the bed joints of the masonry at a shallow angle in order to engage as much of the face masonry as possible. The diagonally drilled holes are then injected with epoxy grout, and a stainless steel helical twist tie inserted in the hole, providing 300–450mm of embedded tie on each side of the crack. The ties are installed in each course, alternating in direction from side to side. The outer ends of the ties are finished 25–30mm from the face, and any surplus epoxy is mopped up and cleaned off before it hardens. The joint is then made good with pointing mortar. Because the ties have a good bond, they are able to resist movement along their length, but are flexible enough to allow the small vertical and horizontal movements that naturally occur in masonry construction.

**Stone repair** can be achieved by a resin-bonding agent in combination with stainless-steel dowelling where the break in a stone is clean. Where the stone cannot be repaired, careful measurements should be taken and a **replacement stone** cut by a supplier. The new stone should match those around it in type. The “dressing” or tooling of the stone should match in a more general way. It is good if it is similar, but not identical, so that the distinction between new and old can be seen on careful examination. Where replacement bricks are needed, they should be salvage brick chosen to match the existing brick.

### 7.14 CONSOLIDATION OF RUINS

The consolidation of the masonry of ruined buildings generally proceeds as outlined above. These procedures are all in accordance with the Advice Series publication *Ruins – The Conservation and Repair of Masonry Ruins*.



A well-maintained ruin where vegetation is controlled and wall tops are protected

Control of vegetation and protection of exposed wall tops are two critical areas which are dealt with elsewhere in this section and also by the Advice Series. Killing or removing vegetation, especially ivy, without conservation work taking place at the same time can cause serious damage and collapse. The best course of action is to keep the ivy clipped back to reduce weight and wind-loading on the walls until a repair programme is put in place.

Ruined 18th- and 19th-century buildings are quite likely to have timber lintels in window and door openings – usually of softwood, which will have rotted. Where relieving arches have been provided on the inside and flat arches on the outside, it may not be necessary to do anything more than providing some packing in the void left by the loss of the lintel, which may also have been used as the springing of the relieving arch. This is best done using a piece of masonry clearly not part of the original structure. Where the opening would be left unsupported, then a pre-cast concrete lintel may be inserted in place of the lost timber lintel.

Deliberately enlarged or fretted-out openings will continue to fail in the absence of supporting lintels or arches. Where an adequate depth of masonry survives above the opening, it is possible, after the consolidation process, to reinforce it to act as an arch. This is achieved by drilling holes at right angles to the shape of the opening to receive threaded stainless steel rods set in epoxy mortar. These holes should preferably be drilled through the joints in order to reduce disturbance of the masonry and, where the

surviving soffit masonry is poorly bonded, a stainless-steel washer and nut fitted on the end of the threaded bar (once the epoxy is set) can be used to retain the stones in place.

Buildings abandoned to become ruins but which retain all their original openings intact should be protected from vandalism by the insertion of galvanised steel grilles at ground level. Lintels and wall tops will have to be treated as described already, and the remains of the timber roof structure or floor structures should be removed, since their collapse is likely to destabilise the masonry.

## 8 TIMBER IN THE NAVIGABLE WATERWAYS

- 8.1** Timber used in lock gates, piles or fendering was originally oak (and later, in repairs, greenheart) but is now almost exclusively Ekki or its equivalent. Ekki and its equivalent, dense African hardwoods, are not generally amenable to the application of anti-rot treatments because of their oiliness and density, which inhibits penetration. They may, however, still be coloured following the application of a barrier primer containing aluminium.



Lock on the Barrow Navigation

Lock gates and, especially sluice paddles need constant repair and maintenance. In the lock gates pictured here, the gates are fully shut and the rack is fully down but there is a large volume of water entering the lock.

Waterways Ireland has been using steel in lack gates for some time combined with traditional timber to maintain visual character.



- 8.2** Sluice paddles are traditionally made of elm, stiffened by being bolted through from bottom to top, the same bolts being used to attach the extension rods to the rack and pinion gear. The elm is permanently in a saturated state when in use and has to be pre-soaked over a long period before installation to ensure that it is fully swollen in order that it will not jam after installation. In that saturated state, it is not possible to apply anti-rot treatment.



Tank for soaking paddles. The tank was designed and made by Waterways Ireland



A replacement softwood post, now severely decayed. A protective membrane would prolong the life of the timber

- 8.3** Timber sourced from sustainable softwoods and not continuously in a wet situation should, wherever possible, be pressure-treated to prevent fungal decay. This is ideally carried out after it has been shaped and prepared for use. The preferred softwood is European larch. Where a decorative finish is not required, but additional wet protection would be useful, then the application of Sadolin or its equivalent would provide both colour and the extra protection.
- 8.4** A finished, coloured paint system may be applied to pre-treated timber by first applying an aluminium-based primer, two coats of emulsion-based paint followed by one coat of pigmented resin-based paint, which may also be emulsion-based if applied in dry, warm weather.
- 8.5** Consideration might be given to protecting the upper surface of large timbers by ‘vulcanising’ or bonding a membrane on to prevent water entering through end grain on posts or through deep fissures on balance beams and causing decay. The material could be painted the traditional canal black and white.

## 9 IRONWORK

- 9.1 There are two excellent guides available on ironwork:  
*Advice Series: Iron – The Repair of Wrought and Cast Iron*; and *Historic Scotland Guide No. 5: Scottish Iron Structures*.

### 9.2 CAST AND WROUGHT IRON AND STEEL

Ironwork, both cast and wrought, is used extensively on the canal system, mainly in relation to elements of lock gates, bollards and railings.

Iron for casting became readily available after the development of the cupola furnace in 1720, which led as the century progressed to cast-iron columns and elements for bridges, as well as bollards, becoming widely available. In the early years of the canal system, wrought iron would, for the most part, have been made in local workshops by hammer working of cast-iron bars. It is possible that some survives from that time. The supply in the United Kingdom was improved greatly by 1776, but the big change came around 1784, when large batches of hammer-beaten and mill-rolled bars and plates became available. Final working may still have been local, but quality and uniformity would have been greatly increased.

The rack and pinion gear for raising and lowering paddle gates and bollards are likely to be the most common cast-iron elements, whereas wrought iron would have been used for the “T” and “L” straps reinforcing the joints on the lock gates, the gate gudgeon anchors (at the upper hinging point), the extension bars between the paddles and the rack and pinion gear, windlass handles and guard rails on the gates and elsewhere.

Cast iron is reasonably resistant to corrosion but does need a good protective paint system. Wrought iron is more susceptible to corrosion. Early blacksmith-produced wrought-iron elements may be susceptible to breakdown due to poor welding of the laminations created by the beating and folding process. Later wrought iron will tend to be more uniform, but both need good quality paintwork to retard corrosion, and this also applies to bolts and coach screws.

By 1850 steel was available, but it is unlikely to have been much used until twenty or so years later when it became widely available. The ease of working steel made it popular, particularly as a substitute for wrought iron. Steel, however, has very poor resistance to corrosion, and so modern replacement elements need to be galvanised when made of steel, since wrought iron is now, for the most part, unavailable.

- 9.3 The rack and pinion gear and other ironwork in storage in Tullamore and other yards should be inventorised and properly stored for re-use elsewhere for repair or replacement.

#### 9.4 PAINT SYSTEMS FOR METAL GENERALLY

Most of the iron and steelwork used in the waterways will fall into the corrosion environment category C3, medium corrosion risk. However, some of the bridges carrying road traffic may be treated with de-icing salt in winter, which would push them into the higher category C5.

Preparation is the key word for repainting both cast and wrought iron. Painting over rust will lead to breakdown of the paint coating, and so, with items that are in situ, mechanical wire brushing may be employed where access is easy. However, in more awkward areas manual wire brushing, as well as needle guns, may be required.

The newly cleaned and exposed iron needs to be over-coated as soon as possible. Once all rust has been removed, the surface should be cleaned using white spirit and, as soon as it is dry, the first coat should be applied. Wet paint migrates away from sharp edges and small inclusions such as specks of rust. In preparing the surface for repainting, it is then essential that sharp edges be smoothed and that final cleaning be thorough.

The general paint standard for both cast and wrought iron is two coats of zinc-based primer and one coat of micaceous iron oxide followed by two coats of decorative finish. Where elements have been removed and are to be re-used they can be thoroughly prepared by blast cleaning or, where they stand alone, can be blast cleaned followed by a longer-life paint system.

It is important to emphasise, however, that blast cleaning is only suitable for solid elements and should not be used on decorative ironwork or castings with impressed designs. Early paint systems incorporating lead oxide fillers were very successful by virtue of great thickness of the paint coating and its long-term elasticity.

Modern coatings which appear to be performing well are composed of waterborne styrene acrylics. When brush applied, four coats of water borne styrene acrylic will be needed, followed by a finishing coat of waterborne acrylic which, in total, build up to a total film thickness of 385 microns. These paints may also be applied by airless spray in the same number of coats to provide the same film thickness.

Old coatings may contain red lead and the complete removal or preparation for overcoating such paint require special precautions for the operatives, (as set out in *The Control of Lead Work* (3rd edition, HSE) 2002, *The Safety, Health and Welfare at Work Chemical Agents Regulations Statutory Instrument 619* of 2001 and the HAS Guide *Safety with Lead at Work*.)

#### 9.5 PROTECTION OF UNGALVANISED STEELWORK

For steelwork that has not been initially galvanised and is exposed in the soffit of bridges or other structures, extended life systems can only be achieved by blast cleaning and preparation, followed by similar systems to those already described for ironwork. Steelwork embedded in a concrete deck but exposed on the soffit could, in

addition, have impressed current cathodic protection incorporated to reduce the maintenance requirement and extend the life of the structure. Where blast cleaning is employed as preparation, then the appropriate standard for the finished work is Swedish Standard SA2.5, with which all metalworkers are familiar.

## 10 PROTECTED OR LISTED BUILDINGS

There are excellent guides available in this area, mainly the Department of Arts, Heritage and the Gaeltacht's *Advice Series* volumes *Maintenance*, *Windows*, *Roofs*, *Brick*, *Energy Efficiency*, and *Access* and Historic Scotland's *Repair of Historic Buildings in Scotland*.

The conservation of historic buildings, whether protected, listed or otherwise, should proceed in the same manner. Some general guidelines are given below.

**Routine maintenance**, such as gutter and downpipe cleaning, should be undertaken at least once a year. Repainting in the same colour scheme at approximately five-year intervals is generally exempt from Listed Building or Protected Structure Consents. The same is true in relation to other structures within the curtilage such as walls and fences or ancillary buildings. Internal routine maintenance is generally similarly exempt but, in the case of protected or listed structures, there may be specific features which may not be painted without consent.

Works involving the complete replacement of existing materials (such as re-roofing with new slate, the replacement of gutters or downpipes in a different form, the replacement of windows or doors, changes to the internal layout, or the removal or replacement of items of internal joinery or fixtures) will all require Listed Building **Consent or Planning Permission**. Replacements and renewals may require Consent or a Declaration, even where these works involve the introduction of like for like. Reaching agreement between Waterways Ireland and the various planning authorities as set out in Section 5.3 would clarify much of this area.

Repairs to **windows or external doors** should be carried out in softwood to match the original. The nearest equivalent today would be treated European Redwood or treated Douglas Fir which has been sourced as: 100 per cent heartwood, close grained, 8–10 grains per cm, radially cut and air dried.

Routine painting should be carried out in a way that does not result in the excessive buildup of paint. Preparatory sanding should be done by hand on glazing bars but may be done by orbital sander on other flat areas. Paint for external walls should be vapour-permeable so as to prevent a buildup of moisture within the wall which will inevitably evaporate on the inside.

Linseed oil putty should be used for re-glazing or reinstatement of missing putty. Make every effort to **retain original glass**, which adds greatly to the character of buildings. When re-glazing, it is important to remove all of the existing putty including backing putty. Mastics or silicone should never be used to hold glass in place. It may be necessary to remove an excessive buildup of paint, especially in the running grooves of the frames. This can be done using a hot air gun and scraper or dichloromethane stripper, but not caustic strippers.

When **external render** needs to be renewed, it is important that it be fully lime-based (i.e. no added Portland cement), since maintaining high vapour-permeability will greatly reduce the risk of damp staining on the inside due to trapped moisture or the evaporation of capillary moisture. Any replacement of **internal plaster** should be fully lime-based for the same reasons. A lime putty mix can be used internally and since it sets by carbonation, can be purchased pre-mixed with reinforcing hair or fibres already added. **Dry lining** should be avoided, as it creates more problems than it solves. Lime-based renders and plasters are easily applied by general plasterers, who simply have to adapt to the different setting times and the need to protect it during setting and for a time afterwards – known as curing or ‘aftercare’.

In areas where rising damp from capillary moisture is a problem, its effect can be reduced by preventing soil contact with the rising wall. The simplest procedure is to excavate a narrow trench around the perimeter of the building down to foundation level and back-fill with clean, single-sized 12–15mm gravel or stone, wrapped in a blanket of Terram, and protected at the surface by a paving slab or footpath.

Good **ventilation** is critical to the wellbeing of buildings; in the general spaces via windows and chimney flues, in the roof spaces and under suspended timber ground floors. Where the ventilator is provided by a specially produced brick or tile, that also helps to reduce the rise of capillary moisture. When a traditional suspended timber floor or roof is being insulated, it is important to maintain the flow of air to ventilate the spaces and around the structural timbers.

# **APPENDIX I**

## **CONVENTIONS, CHARTERS AND THE LEGISLATIVE BACKGROUND**

## APPENDIX I

### Conventions, Charters and the Legislative Background

Organisations and individuals who deal with historic buildings should be aware that there are international codes which govern the conservation approach to be taken, and that governments have incorporated such codes into national legislation and guidelines. For those with responsibility for decision-making, it is important to be familiar with this background.

Governments throughout the developed world had begun to debate the need to protect their cultural heritage during the 18th century; this in turn resulted in the enactment of legislation, for the most part, during the 19th century. The one outstanding exception was Sweden, which had promulgated a decree as early as 1666.

A conference held in Athens in 1931 made the first attempt to address the core issues of conservation on an international scale. A year later, the assembly of the League of Nations formally agreed to communicate its recommendations, known as the Athens Charter to its member states. UNESCO (the United Nations Educational, Scientific and Cultural Organisation) then took up the challenge of providing binding treaties on the principles of conservation. In 1954 the constitution of UNESCO was amended so that the executive board represented the countries that nominated them, and thus the Hague Convention of 1954 was the first such binding international agreement. The Council of Europe produced its first Charter in 1963, followed in 1964 by the Venice Charter of UNESCO. The following year, 1965, the International Council on Monuments and Sites, (ICOMOS) was founded, and together with UNESCO and the Council of Europe it has produced a regular output of Charters right up to the present time.

The international documents governing the conservation of heritage are of two kinds: Conventions and Charters. The principal difference is that ratification of international Conventions carries with it the obligation to incorporate its provisions into national legislation. Conservation Charters are statements of principle and do not have the force of law. Their provisions are, however, frequently reflected in national legislation.

Ireland and the United Kingdom have ratified two such Conventions: the UN World Heritage Convention (1972) and the Convention for the Protection of the Architectural Heritage of Europe (1985). Provisions of these Conventions have been incorporated into legislation.

The Charters are generally short and concise. They have been produced since 1963 and will continue to be produced as the need arises. To date the best known are probably the Venice and the Burra Charters. Access to the full range of ICOMOS charters can be had through [www.icomos.org](http://www.icomos.org). Access to their contents is greatly helped by guides such as The Historic Scotland Guide to International Conservation Charters.



ICOMOS has adopted 14 Charters to date, of which the most relevant are:

- International Charter for the Conservation and Restoration of Monuments and Sites (the Venice Charter) 1964;
- Charter on the Built Vernacular Heritage 1999;
- The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter) 1981/2011;
- ICOMOS Charter: Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage 2003;
- Joint ICOMOS/TICCIH (The International Committee for the Conservation of the Industrial Heritage) Principles for the Conservation of Industrial Heritage Sites, Structures, Areas and Landscapes 2011;
- Guidelines for Education and Training in the Conservation of Monuments, Ensembles and Sites 1993;
- Principles for the Recording of Monuments, Groups of Buildings and Sites 1996;
- Principles for the Preservation of Historic Timber Structures 1999.

The most relevant headings covered by the Charters from the Council of Europe, UNESCO and ICOMOS are as follows:

- Choice of Materials and Techniques
- The Design of New Works
- New Use, Re-Use, Adaption and Utilisation
- Stabilisation or Consolidation
- Treatment of Context
- Management
- Non-Intervention
- Preservation
- Restoration
- Replication
- Reconstruction

State legislation also owes much to the Burra Charter, adopted by the Australian branch of ICOMOS, which is notable for the clarity of its definitions of conservation actions.

**Technical guidelines produced by national governments** are based on the Charters.

In the Republic, the Department of Arts, Heritage and the Gaeltacht publishes the *Advice Series* of guidance documents, relating to a wide range of conservation areas. These can be accessed at: [www.ahg.gov.ie/heritage-publications](http://www.ahg.gov.ie/heritage-publications). Also on this website can be found the publication *Architectural Heritage Protection: Guidelines for Planning Authorities*

2007, which provides clear summaries of the principles of conservation of architectural conservation and sets out the provisions of the relevant Irish planning legislation.

In Northern Ireland, guidance documents can be found on the Northern Ireland Environment Agency and Department of Communities websites [www.doeni.gov.uk](http://www.doeni.gov.uk) and [www.communities-ni.gov.uk](http://www.communities-ni.gov.uk).

Historic England and Historic Environment Scotland both publish a wide range of guidance on their websites <https://historicengland.org.uk/advice/technical-advice> and <https://www.historicenvironment.scot/archives-and-research/publications>

All such government-sponsored guidance can be taken as being in compliance with the Charters, especially in relation to routine work. However, when less usual circumstances arise or projects have complex issues, direct recourse to the Charters and interpretation of them may be necessary.

# **APPENDIX II**

## **GLOSSARY OF TECHNICAL TERMS**

## APPENDIX II

### GLOSSARY OF TECHNICAL TERMS

**Ashlar:** a term used for fully squared and finely wrought blocks of stone, usually with very fine mortar joints of between 3mm and 4.5mm. It is almost always facing material backed either by rubble or brick, fully bonded to the face. Typical blocks are of the order of 300mm high on the face, between 225mm and 450mm deep at right angles to the face, and between 375mm and 1m long on the face.

**Bentonite:** a naturally occurring, highly absorbent clay with special mineral properties used for drilling mud, as a purifier and as a water barrier. Found mainly in the U.S., China, Turkey and Germany.

**Block on Course:** this is the more usual form of fine masonry for engineering structures. It looks like ashlar. The joints may not be as fine. Typical blocks are 300mm high on the face and are between 400mm and 650mm deep at right angles to the face, and up to 675mm long on the face and are normally coursed with squared rubble to the full depth of the wall.

**Brick:** manufactured masonry units of standard size made by kiln burning clay or shale, which had previously been moulded to shape. Engineering brick is made from similar base material, but is burned for longer and at higher temperatures so that it is almost fully vitrified.

**Calcium lime (CL):** also known as air lime, is produced as quick lime, dry-hydrated lime and lime putty. It requires air-drying to set, and the slow process of carbonation to produce hardness.

**Casein:** casein is milk protein sometimes used in grouting and in limewash.

**Cast Iron:** cast iron is an alloy of iron and carbon with a carbon content greater than 2 per cent. It is hard but brittle and is mainly used to produce iron objects by pouring the molten iron into a mould; hence "cast".

**Cathodic Protection:** a method of protecting iron or steel from corrosion by coupling it with a sacrificial metal called an "anode" or by applying an electric current to prevent the ion exchange which causes corrosion.

**Coarse Stuff:** coarse stuff is the basic mortar mix for putty lime plaster. It consists of putty lime and sand, mixed and stored to the exclusion of air for a minimum of one month, following which it may be knocked up ready for use.

**Cut Water:** a V-shaped masonry structure extending from the upstream face of a bridge pier for the purpose of deflecting debris and preventing its accumulation.

**Curing:** the process of controlling the drying out of plaster coats to prevent cracking.

**Emulsion:** a colloidal suspension of oil in water, or, when related to paint, a suspension of the oil/pigment mix in water.

**Flaunching:** a method of pointing the exposed upper surfaces of rubble masonry walls to facilitate the draining of rainwater from the surface.

**Fretting:** the continuous erosion of an unsupported opening in masonry, either by gravity or frost wedging, or wedging caused by the growth of plant roots into joints.

**Galvanising:** the process of applying a coating of zinc to steel or wrought iron, generally by the immersion of the iron or steel object in molten zinc, a process known as hot dip galvanising.

**Grout:** grout in conservation work is a liquid mixture of lime and fine sand used to fill voids in masonry by injecting under low pressure, sometimes with the addition of an intrusion aid called casein.

**Dubbing Out:** the making good of local hollows in masonry before applying a full coat of plaster.

**Gate Gudgeon Anchor (Land Anchor):** the assembly (including the pin) forming part of the top hinge of the lock gate, which is restrained by anchoring it behind the lock walls.

**Hair:** hair for addition to plaster as a reinforcement may traditionally be sourced from goat, horse or cow hair, but synthetic hair may also be used where natural hair is not available. Hair must be free of dust, grease and be at least 30mm long.

**Hot Mix Mortar:** made by mixing quick lime with sand and water on site for immediate use.

**Hydrated:** this means chemically combined with water. Hydrated limes may be high-calcium limes or hydraulic limes. The process of hydration of quick lime is known as slaking.

**Hydraulic lime (HL):** a manufactured product which incorporates a pozzolan into calcium lime to produce a hydraulic set. Designations are HL 2, HL 3.5 and HL 5.

**Intrados:** the underside of an arch or an arched structure.

**Keying:** the process of scoring a plaster coat after it has become firm to provide a key for the subsequent coat.

**Land Anchor:** see Gate Gudgeon Anchor.

**Laths:** laths are strips of softwood, generally 25mm x 5mm, either riven or sawn, and used as a base to support plaster on ceilings and wall linings.

**Natural hydraulic lime (NHL):** is produced from rock, the composition of which, when burnt to lime, produces a lime with a hydraulic set. Natural hydraulic limes are produced in three strength categories (NHL 2, NHL 3.5 and NHL 5), depending on the temperature at which the limestone is burnt.

**Nib:** plaster which when squeezed up between the laths curls over their back and, on setting, holds the plaster in place.

**Pit Sand:** sand dug from the ground rather than produced by crushing.

**Plaster:** the covering of internal walls and ceilings with lime-based mortar.

**Pozzolan:** an additive which accelerates a set in mortar. Can be volcanic ash, brick or tile dust.

**Prompt:** an almost instantaneously setting and fast-hardening natural cement made from a unique limestone with no additives.

**Puddle clay:** a water-retaining material used for lining, made from clay or heavy loam. Known in England as cob, it is similar to adobe. Used extensively in canals.

**Putty Lime:** a non-hydraulic lime containing a high proportion (at least 94 per cent) of calcium carbonate ( $\text{Ca CO}_3$ ). After burning and slaking, it is carefully sieved and stored in a wet condition to the exclusion of air for a minimum of one month.

**Putty Lime Plaster:** made from a mortar consisting of putty lime, sand and, frequently, hair. After application, it depends on drying to achieve a set and carbonation, (i.e. the absorption of carbon dioxide  $\text{CO}_2$  from the air) to achieve hardness.

**Quick Lime:** this is calcium oxide ( $\text{CaO}$ ) as produced by burning limestone or other calcareous stones (generally designated CL, i.e. calcium lime). As produced, it is available in: lump form, as extracted from the kiln; in granular form, i.e. crushed to a uniform granular size; or in powdered form.

**Rack and Pinion:** a device for raising and lowering the paddles in lock gates or sluices. It consists of a flat-toothed casting attached to the item to be raised or lowered on the one

side, and on the other side a toothed gear wheel which engages with it and which, when rotated, causes the rack to be raised or lowered.

**Random Rubble, Uncoursed:** rubble stonework placed as it is found, randomly, with no effort at coursing.

**Random Rubble Built in Courses:** this rubble masonry is built in random fashion, but each lift of masonry is finished to a level course, usually by the incorporation of smaller levelling stones.

**Regular Coursed Rubble:** fully squared masonry with larger joints and therefore not as finely squared as ashlar. The courses vary from 100mm high to 225mm high on the face, and all courses are of equal height.

**Relieving Arch:** an arch incorporated into a wall above an opening trimmed by a lintel. Its purpose is to reduce the load on the lintel.

**Render or Rendering:** the application of lime mortar as a coating to the exterior of a building.

**Scour:** in relation to bridges, the process by which the water rushing under the arch of a bridge removes material from the base of the bridge piers.

**Scouring Back:** the process undertaken when a plaster coat is firm, but before it dries, to provide a key by working it with a cross-grained float, followed by scoring with a specialised tool.

**Scratching:** the keying of undercoats of plaster or render to take subsequent coats.

**Screeding:** the application of a plaster ground to which other coats of plaster are ruled in to achieve a flat surface.

**Sharp Washed Sand:** sand with sharp, angular grains that interlock well with each other. It is prepared by washing, to remove clay or organic material.

**Silver Sand:** fine sand of consistent quality, used for mixing with lime putty to make the fine finish plaster coat on ceilings and walls.

**Spandrel Walls:** the approximately triangular sections of wall between an arch and an abutment, or between arches.

**Squared Rubble Built to Course:** squared masonry is roughly squared similar to the regular coursed rubble but with courses of varying height on the face.

**Turning:** the point at which lime plaster has set sufficiently that no amount of adding water will make it re-workable.

**Uncoursed Squared or Snecked Rubble:** this masonry is made up of blocks, fully squared, of different sizes on the face, both vertical and horizontal. They are assembled in a semi-random pattern, but producing a continuous uniform face.

**Vousoir:** a wedge-shaped stone or brick used to form an arch or vault.

**Wet Dash:** known as 'harling' in Scotland and England, this is lime mortar coating that is thrown at an external wall and produces a traditional textured finish. Can also be called 'roughcast'.

**Windlass:** a device used to turn (wind) an axle which, in relation to canals, is mostly connected with the operation of rack and pinion devices. A windlass handle is an L-shaped handle facilitating manual rotation of the axle.

**Wrought Iron:** historically, wrought iron was made by heating cast-iron bars, beating them, folding them, reheating and refolding over many operations; a process which released much of the carbon by oxidation. The low-carbon iron was then tough, malleable, ductile, quite corrosion-resistant and easily welded by beating two white heated sections together. Later, wrought iron was produced by beating and working in a mechanised mill. Wrought iron was widely used for beams, rods, bars, channels and straps of various shapes, as well as for decorative work in gates and railings. Wrought iron is no longer produced commercially and its function has generally been overtaken by steel.



# **APPENDIX III**

## **TECHNICAL SPECIFICATIONS FOR MORTARS, LIME, LIMECRETE ETC**

## APPENDIX III

### TECHNICAL SPECIFICATIONS FOR MORTARS, LIME, LIMECRETE ETC

#### A GENERAL SPECIFICATION FOR NHL (NATURAL HYDRAULIC LIME) MORTAR, GROUT AND LIMECRETE FOR EXTERNAL USE

##### DEFINITIONS

Lime for mortar making is produced in three categories and each category has distinct product types or gradings within the category. The three categories are calcium lime - designated CL, hydraulic lime - designated HL and natural hydraulic lime - designated NHL.

Calcium lime (CL) also known as air lime, is produced as quick lime, dryhydrated lime and lime putty. It is used in mortar mixes and widely used in decorative plasterwork. It requires air-drying to set and the slow process of carbonation to produce hardness.

Hydraulic lime (HL) is a manufactured product which incorporates a pozzolan into calcium lime to produce a hydraulic set. They are designated HL 2, HL 3.5 and HL 5.

Natural hydraulic lime, NHL, is produced from rock, the composition of which, when burnt to lime, produces a lime with a hydraulic set. Natural hydraulic limes are produced in three strength categories, NHL 2, NHL 3.5 and NHL 5, depending on the temperature at which the limestone is burnt.

Hydraulic limes set by chemical reaction in the presence of water and do not depend on drying alone for set and hardness.

##### STRENGTH DESIGNATIONS

The strength designations for natural hydraulic lime, as set out above, are standardised throughout Europe and should bear the European standard EN 459. Hydraulic limes produced by the addition of pozzolan must also conform to the same classification as the natural hydraulic limes.

This specification is for use with natural hydraulic limes only for the production of site mixed building and pointing mortars. The substitution of HL designated limes or CL limes with site additives is not covered or permitted by this specification.

##### GENERAL SPECIFICATION

###### 1.0 WALL CONSTRUCTION

###### 1.1 General

The use of NHL mortars for bedding and jointing structural elements in a wall follows normal good practice for wall construction.

###### 1.2 Building with Brickwork

Bricks, depending on their porosity, may need to be pre-wetted to avoid excessive suction and shrinkage of the mortar. Excessive wetting should be avoided as this may lead to instability and/or mortar runs.

### **1.3 Stone Masonry**

The need for suction control in building with stone depends on the stone type. Hard limestones should need no advance wetting but soft porous sandstones and some soft limestones may need some pre-wetting but, generally, wetting of stone is unnecessary. Stones should be bedded with their long axis horizontal and any voids greater than normal bed thickness should be filled with pinning stones to allow for reasonable additional courses of masonry in a day's work and to avoid the shrinkage problems which may arise due to the use of excessive volumes of mortar.

### **1.4 Finishing**

Pointing may be undertaken as a follow on operation in which case the joints should be raked back as set out in the following specification, but they may also be finished in a single operation, in which case it is best to leave the mortar slightly proud and to return to it when it has started to dry, at which time it can be cut back and struck to the agreed pointing detail.

## **2.0 POINTING, REPOINTING AND GROUTING**

### **2.1 Preparation**

Joints for repointing need to be raked out to a depth at least equal to  $2\frac{1}{2}$  times the thickness of the joint. Joints should be thoroughly cleaned and free of the roots of vegetation or any build up of humus. A variety of raking tools will be required for cleaning out joints. Many of these will be home made, but bent spikes and old hacksaw blades will be found useful. Chisels should not be needed on random rubble masonry.

### **2.2 Suction Control**

It may be necessary to apply water to reduce excessive suction especially on bricks and porous stone. This should be done the day before and, where necessary, several applications of water should be made with the last damping before repointing commences. Pinning stones which have been disturbed during the raking out process shall be retained and re-set in their original position. Where pinning stones have been lost they should be replaced. The purpose of the pinning stones is to reduce the area of exposed mortar and so assist its long term durability. Pinnings should be inserted in large joints to reduce the depth of the joint to between 15mm and 20mm.

### **2.3 Procedure for Repointing**

It is essential that the masonry is neither too wet nor too dry at the commencement of repointing and it is essential, therefore, that, in the preparatory stage, trials on suction control be carried out to determine the extent of pre-wetting so that the joints are just damp and not wet at the time of repointing. The mortar needs to be well compacted into the joint. To achieve this, a range of steel bars, curved to allow penetration into the joint and with a flat spatula like end, slightly curved, and of a width suitable to the joint, should be used to compact the mortar in place. Bars of varying width will be required for use in repointing on random rubble masonry walls. The mortar should be struck off flush with the face of the innermost of the stones which form the joint. When the mortar is going off, but before it has hardened, the surface of the joint should be hammered with a stiff bristle brush which will raise the coarse aggregate in the mortar and have the effect of reducing the risk of cracking.

### **2.4 Grouting of Rubble Masonry**

This is a technique for solidifying the core of a wall where the original mortar has decayed or perhaps where the core was not originally mortared and the inside and outside leaves of the wall have started to take on an independent existence. The procedure is relatively straightforward. It has to be preceded by the consolidation of the exposed masonry, by the removal of vegetation, the

raking out and cleaning of joints and the repointing of joints. In the raking out process some joints are raked through to the core of the wall in a regular pattern and a plastic grout tube is fitted and held in place by the repointing mortar. On completion of the repointing, a lime grout sometimes containing an intrusion aid such as “casein” is pumped in using a hand operated grout pump and commencing at the lowest grout tubes. Grouting using a gravity system fed from an elevated tank may also be used, but the tank will generally need to be elevated by between 2 and 4 metres. Pumping continues until the grout appears at the next tube vertically. Both tubes are then temporarily plugged and the sequence continues along the wall and thence to the next level, etc. As the grout hardens the grout tubes can be withdrawn and the joints re-pointed. Grout, by virtue of its high water content, is not suitable for filling very large voids which may have to be opened up to allow sufficient access for conventional filling with mortar and small stones.

### 3.0 CURING AND PROTECTION

#### 3.1 Curing

Completed work needs to be protected from direct sunlight or excessive drying by wind. Netted scaffolding would usually provide sufficient protection in that regard. Protection against rain will also be required during the first seventy-two hours. Plastic sheeting is generally adequate for that purpose. Work should not be started in frosty conditions, or with temperatures below 5° centigrade generally.

#### 3.2 Shrinkage

Light shrinkage may occur on heavier joints during the first twenty-four hours. If this occurs spray on a light water mist and tap gently with the bristle brush to close the crack.

#### 3.3 Protecting NHL Mortars

The setting properties of NHL mortars require the following protection:

<b>Mortars made with of:</b>	<b>Protect from frost, rain, strong wind or direct sun for minimum</b>
NHL5	48 Hours
NHL3.5	72 Hours
NHL2	96 Hours

The preferred form of protection is damp hessian cover which, with re-damping, could also, in some cases, contribute to curing the mortar. Plastic sheeting, when used for rain protection, should not be allowed to brush against fresh work.

Frost protection should be applied when frost is forecasted during the night or within the protection periods given above from completion of work. Work should not start in frost conditions or with temperatures below 5° centigrade generally but, when working with NHL 2 or in rendering with fine finishing coats, when the temperature is below 8° centigrade.

Protection from drying winds or hot weather must be provided for example by using shading sheets on scaffolding.

#### 4.0 MORTAR MIXES

##### 4.1 Mix Proportions NHL/Sand (based on NHL with a bulk density of 0.72kg/dm<sup>3</sup>.)

TYPE OF MASONRY	SAND	NHL2	NHL 3.5	NHL 5
Soft Bricks/Soft Stone	(A)	1 : 2	1 : 2.5	-
Medium Brick/Medium Stone	(B)	1 : 1.5	1 : 2	1 : 2.5
Hard Dense Stone/Hard Brick	(B)	-	1 : 1.5/1 : 2	1 : 2

Sand A: Sharp Medium

Sand B: Sharp Coarse

Grit to match existing mortars in the range 8mm down to 5mm

##### 4.2 Application of Mixes

NHL 2 mortar for sheltered locations

NHL 3.5 mortar for general use

NHL 5 mortar for extreme exposure on permanently wet situations

##### 4.3 Grout

Fine: Use neat lime or with casein added to aid intrusion and reduce water content.

Composition of neat lime:	NHL 5	-	max. 60 litres water per 25kg bag NHL
	NHL 3.5	-	max. 50 litres water per 25kg bag NHL
	NHL 2	-	max. 40 litres water per 25kg bag NHL

Coarse: Use sharp medium sand (A) as per grading below.

Composition:	NHL 5	-	1 25kg bag NHL + 60 litres of sand + 60 litres of water (max.)
	NHL 3.5	-	1 25kg bag NHL + 50 litres of sand + 50 litres of water (max.)
	NHL 2	-	1 25kg bag NHL + 40 litres of sand + 40 litres of water (max.)

The maximum amount of water includes the water contained in the sand. Water should be added to obtain a paste of the required fluidity, to a maximum as set out above. If casein, to a maximum of 1% by weight, is added, water may be reduced by between 25% and 50%.

##### 4.4 Concrete (Limecrete)

Sand B: Sharp Coarse

Gravel: 12mm – 15mm clean washed gravel or crushed limestone.

Lime: NHL 5

Mixed Proportions:	NHL 5	:	Sand	:	Gravel
	1	:	1.5	:	2.5

Procedure: Mix the sand and lime for approximately 15 minutes before adding in the gravel. The final volume of gravel may need to be reduced slightly to aid workability, particularly with crushed stone. Keep the water content to a minimum to reduce shrinkage. The consistency should be that of a fat mortar which will require tamping when being placed.

#### 4.5 Sand Gradings

##### Ideal Grading for:

Sharp Medium Sand (A)	Size mm	% Passing
	2.36	100
	2.00	98
	1.25	88
	1.0	83
	0.63	70
	0.4	52
	0.315	42
	0.2	25.5
	0.125	10
	0.075	0

Sharp Coarse Sand (B)	Size mm	% Passing
	3.35	100
	2.0	95
	1.25	85
	1.0	81
	0.63	68
	0.5	60
	0.4	51
	0.315	41
	0.2	25
	0.125	10
	0.075	0

#### 4.6 Comparison of Typical Bulk Densities of Natural Hydraulic Lime Sources

Manufacturer	RBD (kg/dm <sup>3</sup> )	Factor	% difference in volume of lime
Roundtower	0.636	1.00	-
Cal Hidraulica	1.00	1.57	+57
Jura-Kalk	0.91	1.43	+43
St. Astier	0.72	1.13	+13
Castle	0.72	1.13	+13
Otterbein	0.68	1.07	+7

#### 4.7 Storage of NHL in Bags

The bags of lime shall be stored off the ground (e.g. on pallets) in a weatherproof well ventilated store. Naturally Hydraulic lime produces a set when mixed with water and therefore must be kept dry until used.

#### 4.8 Mixing of Mortar

A normal mixer (used for general mortar mixing) may be used. First introduce half of the sand, followed by all of the lime for the mix. After two to three minutes mixing (dry) add the remaining half of the sand. Add the water slowly until workability is achieved. Mix for twenty minutes minimum, or longer for improved workability with less water. (The less water used to achieve the desired workability the less shrinkage in the finished work).

#### **4.9 Health and Safety Relative to the use of Lime**

Dry bagged lime and lime mortar is caustic and can dehydrate the skin. When using lime it is advisable to wear gloves and protective overalls and goggles, and if working with lime for prolonged periods, to protect exposed parts of the body with a barrier cream. A dust mask should be worn when handling the dry lime from the bag and from bag to mixer or in any situation where lime dust may be released.

#### **5. Removal of Cementitious Pointing**

Cementitious pointing which is finished flush with the face of the masonry may not be amenable to removal without damaging the masonry if it is well bedded. In general, it is better not to attempt removal in those circumstances. Failed cementitious pointing should be capable of removal without the use of chisels. Very often, it is not inserted deep enough in the joint and with shrinkage can come loose. If pockets of cement pointing are difficult to move, holes can be drilled at right angles to the face which will facilitate removal. Hand chiselling may be necessary after the initial removal in order to clean the joint back to the original mortar. Electric saws or discs must not be used. They are difficult to control and cause damage to the stone.

#### **6. Pointing in Marine, Riverine and Canal Environments**

Pointing in the splash zone or where early wetting will occur due to tides or the operation of locks will require a revised mortar mix as follows: the mortar for repointing should be made with NHL 5, as set out above, but with up to a maximum of 10% Vicat Prompt Natural Hydraulic Binder, or equal approved, mixed in just before the mortar is turned out for use.

#### **7. Grout in Marine, Riverine and Canal Environments**

Grouting of masonry which is subject to fluctuating water table by tides or the operation of locks will require the addition of Vicat Prompt Natural Hydraulic Binder, or equal approved, to produce an early set. This should only be necessary where there is evidence that water level within the wall rises with the fluctuating water level outside.

#### **8. The Source of the Natural Hydraulic Lime**

The bulk density of natural hydraulic lime varies with different manufacturers. It is important to establish the bulk density of the lime which is proposed for use so that the mix may be adjusted accordingly. The RBD of the lime on which the General Specification is based is 0.72 Kg/Dm cubed.

## **B GENERAL SPECIFICATION**

### **FOR HOT MIXED LIME MORTARS FOR EXTERNAL USE**

#### **DEFINITIONS**

**Quick Lime:** this calcium oxide (CaO) produced by burning limestone or other calcareous stones which is generally designated Cl, i.e. calcium lime. As produced, it is available in lump form, i.e. as extracted from the kiln or in granular form, i.e. crushed to a uniform granular size or in powdered form.

**Hot Mix Mortar:** is made by mixing quick lime with sand and water on site for immediate use.

#### **MORTAR MADE BY THE HOT MIXED METHOD**

The mortar is generally made using either granulated quick lime or powdered quick lime mixed with well graded sand, which is clean and free of clay or organic particles, and, where replicating historic mortars containing grit, grit of the appropriate size is also included and, ideally, should be premixed with the sand.

The mortar is made by mixing sand, or sand and grit, in the proportion of 4 to 1 of granulated quick lime, or 3 of sand plus aggregate to 1 of lime, depending on the application. Mixing may be done by hand, or in a mortar mill, by first mixing the lime and sand and then gradually adding water at a rate sufficient to prevent the mix from overheating, but taking care not to over water. The mortar so produced may then either be used immediately while hot, or when it has cooled.

#### **HEALTH AND SAFETY ISSUES**

Quick lime is classified as a hazardous material and, while Portland cement and hydrated lime products such as putty lime and NHL limes fall into the same category, the risks in handling quick lime are not of the same order. The casual attitudes frequently seen on building sites in the handling of Portland cement and hydrated lime products could, if carried over into the use of quick lime, have serious consequences.

A high degree of protection is required when handling quick lime requiring the use of goggles, face masks, barrier creams and protective gloves at all times. It is a recommendation of this specification that mortars employing quick lime should be used only by highly experienced personnel, supervised by contractors with the appropriate experience in the use of the product.

#### **HOT MIX MORTAR IN USE**

Hot mix mortar may be used in the building of masonry, in pointing or rendering, but its greatest historical advantage was said to be in building masonry, and especially for core filling. The advantages claimed for the use of hot lime mortars can, in certain operations and circumstances, can be quite beneficial. Those advantages must be weighed against the need to confine the work to experienced and conscientious personnel.



## **C GENERAL SPECIFICATION FOR NHL (NATURAL HYDRAULIC LIME) RENDERS FOR EXTERNAL USE**

### **DEFINITIONS**

Lime for mortar making is produced in three categories and each category has distinct product types or gradings within the category. The three categories are calcium lime - designated CL, hydraulic lime - designated HL and natural hydraulic lime - designated NHL.

Calcium lime (CL) also known as air lime, is produced as quick lime, dryhydrated lime and lime putty. It is used in mortar mixes and widely used in decorative plasterwork. It requires air-drying to set and the slow process of carbonation to produce hardness.

Hydraulic lime (HL) is a manufactured product which incorporates a pozzolan to calcium lime to produce a hydraulic set. They are designated HL 2, HL 3.5 and HL 5.

Natural hydraulic lime, NHL, is produced from rock, the composition of which, when burnt to lime, produces a lime with a hydraulic set. Natural hydraulic limes are produced in three strength categories, NHL 2, NHL 3.5 and NHL 5, depending on the temperature at which the limestone is burnt.

Hydraulic limes set by chemical reaction in the presence of water and do not depend on drying alone for set and hardness.

### **STRENGTH DESIGNATIONS**

The strength designations for natural hydraulic lime, as set out above, are standardised throughout Europe and should bear the European standard EN 459. Hydraulic limes produced by the addition of pozzolan must also conform to the same classification as the natural hydraulic limes.

This specification is for use with natural hydraulic limes only for the production of site mixed building and pointing mortars. The substitution of HL designated limes or CL limes with site additives is not permitted.

### **GENERAL SPECIFICATION**

#### **Background Preparation**

Ensure that the background is thoroughly clean and free of loose pointing or old render. Cracks should be cleaned out and sealed with an NHL pointing mortar and allowed to cure for one or two days before rendering starts.

#### **Suction Control**

If necessary, apply sufficient water to reduce excessive suction, especially on bricks and porous stone. This is done the day before, if necessary several times with the last damping before application starts. Apply water starting at the top of the structure. Old bricks require more water than new ones. The top of the structure will dry out before the bottom. In base coats this means that scouring back and keying of the lower section might have to be done later than the upper section. Always dampen areas before applying next coat.

#### **Keying**

Provide adequate keying between background and base coat and between each coat. Criss cross patterns are much preferred to combing.

### **Dubbing Out**

On defaced surfaces or in areas with a large amount of damaged joints, it may be necessary to apply a dubbing out coat to provide a uniform straight surface. In most cases dubbing out will be sufficient and joints and holes will not have to be filled unless quite deep in which case pinning stones shall be used to fill deep holes. When a dubbing out coat is used, let it set sufficiently (8 to 10 hours) before smoothing it and keying it. Apply base coat or scratch coat after approximately two days (more if very deep recesses have been filled) depending on weather conditions affecting the drying out time. The most efficient way to apply a dubbing coat is by harling (cast on).

The final thickness of this coat is minimal, up to 3mm to 4mm from the surface of the deepest hollow filled or enough to allow straightening and keying. The strength should, as always, be compatible with the type of background but a strong mix is recommended (1 : 1.5 or 1 : 2) once the correct NHL strength has been chosen.

### **Repointing before Rendering**

If this is necessary it should be done with the same type of mortar used for the base coat in two coat work.

### **Smooth and Light Textured Finishes**

Use finer graded sands, 2mm down to 75 microns. Make sure to add just enough water to obtain required workability. The more water is added the higher the risk of shrinkage. Do not use lime putty additions as this would also increase the shrinkage potential.

When mortar is firm enough to accept wooden float, proceed to floating up in small circular motions as long as necessary to obtain required finish.

This is a most important phase of the finishing work and should be done diligently and energetically. The surface should not be floated up again to avoid tearing or patches and the skill of the plasterer at this stage, together with curing and protection precautions, is vital to obtain a good finish.

### **Curing**

Check for light shrinkage during the first 24 hours. If noticed, apply light water mist on relevant area or through hessian cover provided. Repeat operation, if necessary, the same day or the next.

### **Coarse Finishes**

Use coarser sands if thick (rustic) granular finishes are required. The thickness of the coat depends on the final finish required. Some of these finishes, especially the ones requiring special skills such as cottage, scraped and travertine rendering, could also be done by using the same type of sand as per smooth and light textured (floated) finishes. In these and tooled renderings (patterned), if initial shrinkage takes place, lightly dampen the surface and re-float the area during the first day or two. Tooling is normally applied when the render is five to seven days old.

### **Dry Dashing**

Throw the chosen aggregate on to soft mortar and leave exposed. To speed up the work a plasterer throwing the aggregate can follow the laying on plasterer.

### Protecting NHL Mortars and Renders

The setting properties of NHL mortars will require the following recommended protection:

<b>Mortars made with of:</b>	<b>Protect from frost, rain, strong wind or direct sun for minimum</b>
NHL5	48 Hours
NHL3.5	72 Hours
NHL2	96 Hours

The preferred form of protection is damp hessian cover which, with re-dampening, could also, in some cases, contribute to curing the mortar in renders.

Plastic sheeting is effective against rain but should not be in contact with fresh work. If too tight it will trap condensation. Plastic does not protect against frost.

Frost protection should be applied even if frost is not occurring at the time of finishing the day's work but is forecasted during the night or within a short time (see suggested protection periods above) from completion of work. Work should not start in frost conditions or with temperatures below 5°C, in working with NHL 2 or, in rendering with fine finishing coats, it should be 8°C. Foil-backed, fibreglass rolls are useful with the fibreglass side in but allowing an airspace.

Protection from drying winds or hot weather could be provided by using shading sheets on scaffolding.

### Three Coat Work

#### First Coat

The first coat has to provide sufficient bonding. Stipple or spatter dash can be used on strong and smooth backgrounds. A trowelled scratch coat is preferred on old bricks or soft surfaces. Use strong mix (1 : 1.5 preferably, NHL 3.5 hydraulic lime : sand). On soft or weak backgrounds use 1 : 2 or 1 : 2.5. Successive coats must be weaker than this coat. The thickness of the first coat depends on the nature of the background, the overall thickness required on the render and the keying function. The normal thickness varies between 3mm and 5mm. Scour back and key (criss-cross keying preferred) once initial setting has taken place.

#### Undercoat

This coat is to be applied two days (or more, depending on atmospheric conditions) after completion of the first coat. If applied "green on green" the waiting period can be less. The good judgment of the plasterer is essential. Its strength should be marginally less than the first coat. Thickness can vary according to the overall thickness required, but it is normally between 10mm and 15mm. It must not be applied over 20mm thick. If this is required, it should be done as an extra coat (two intermediate coats) each not above 20mm. The thicker the intermediate coats, the longer the waiting time before each application.

#### Ensuring a Straight Surface

To achieve a uniform and straight surface, fix vertical timber battens on the wall at 2m to 2.5m intervals. If the wall is uneven use spacers and check that battens are straight with a plumb level. Screed off excess mortar between battens with a wooden straight edge spanning between the battens. When battens are taken down, fill in strips with the same mortar. An alternative is to make running screeds 10cms wide at regular intervals using the battens as described above and applying the undercoat in between them.

Scour back and key as usual after initial setting. Check for shrinkage during the first two days and, if necessary, lightly dampen the relevant area, scour back and re-key. In case of intermediate coats this would apply to each coat.

Do not apply finishing coat for at least two days or until undercoat is adequately firm.

Note: In all renders, coats should be applied firmly to exclude air and any excessive moisture. Always dampen surfaces before applying the next coat. Apply good working practices and follow the protective measures.

#### Finishing Coat

Use NHL 3.5

5mm maximum for smooth or light textured finishes.  
7mm to 8mm for coarse finishes (rough cast etc.)

Stock up sand for finishing coats in one go, especially if no colouring is used. The mortar should be weaker than the one used on the base coat (consult your lime supplier if in doubt). It could be applied after three to four days from completion of base coat. This period may vary a lot and could go up to seven to ten days, depending on the weather condition and on the plasterer judgment.

#### **Health and Safety relative to the Use of Lime**

Dry bagged lime and lime mortar is caustic and can dehydrate the skin. When using lime it is advisable to wear gloves and protective overalls and goggles, and if working with lime for prolonged periods, to protect exposed parts of the body with a barrier cream. A dust mask should be worn when handling the dry lime from the bag and from bag to mixer or in any situation where lime dust may be released.

## D GENERAL SPECIFICATION FOR PUTTY OR AIR LIME PLASTER

### DEFINITIONS

**Putty Lime:** a non-hydraulic lime containing a high proportion, at least 94%, of calcium carbonate ( $\text{Ca CO}_3$ ), which, after burning and slaking, is carefully sieved and stored in a wet condition to the exclusion of air for a minimum of one month.

**Putty Lime Plaster:** made from a mortar consisting of putty lime, sand and, frequently, hair. After application, it depends on drying to achieve a set, and on carbonation, (i.e. the absorption of carbon dioxide  $\text{CO}_2$  from the air) to achieve hardness.

**Coarse Stuff:** the basic mortar mix for putty lime plaster and consists of putty lime and sand, mixed and stored to the exclusion of air for a minimum of one month following which it may be knocked up ready for use.

**Turning:** the point at which lime plaster has set sufficiently that no amount of adding water will make it re-workable.

**Laths:** these are strips of softwood, generally 25mm x 5mm, either riven or sawn, and used as a base to support plaster on ceilings and wall linings.

**Hair:** hair for addition to plaster as a reinforcement may be sourced from goat, horse or cow hair traditionally, but synthetic hair may also be used where natural hair is not available. Hair must be free of dust, grease and be at least 30mm long.

### MORTAR MIXES

Mortar mixes generally are made in the same proportions, whether used on lath or on masonry backgrounds. This specification is for standard three coat work. The mix for the first and second coats are generally the same whether on lath or masonry. The third coat may vary depending on the finish required.

The first and second coats – these coats will be applied using coarse stuff which has been knocked up and to which hair has been added. It consists of sharp washed and graded pit sand, free from clay and organic matter, mixed in the proportions of 3 or 2.5 parts sand to 1 part lime and, if applied to lath, mixed with 7.5 kgs of hair per cubic metre and, if applied to masonry, 5 kgs of hair per cubic metre.

The composition of the third and final coat depends on the surface finish required. For fine, smooth finishes on lath or on masonry the final coat will consist of 3 parts lime to 2 parts silver sand. For other finishes, primarily on masonry, the final coat may consist of 1 part lime to 1 part silver sand to 1 part lime to 2 parts silver sand.

## PLASTERING TO LATH

Laths need to be soaked before fixing so that the shrinkage occasioned by drying stiffens up the structure. Before the application of plaster the lath again needs to be soaked to prevent it from absorbing moisture from the plaster.

First Coat: the first coat is generally 12mm thick, laid on diagonally and firmly to form good nibs above the lath, but care to be taken not to bend the laths during application. The first coat must then be cross scratched and allowed to dry for a minimum of seven days or until it has turned. The first coat is then wetted down before the application of the second coat, which is also of the order of 12mm in thickness. This coat must also be scratched to provide a key and left to dry until it turns. Should it prove necessary to dub out for levelling between the first and second coats, then any such dubbing out must be scratched and allowed to turn before the application of the second coat. If a true flat ceiling is required it will then be necessary to place plaster dots across the ceiling at approximately 2m centres and to run screeds between them. The dots and screeds are allowed to dry green hard before the panels between them are floated in with the final coat.

## PLASTERING ON TO MASONRY

Plastering on to masonry follows the same procedure set out for lath but, in advance, the masonry needs to be cleaned free of dust and wetted down a day ahead of the stipple coat which is cast on. If the masonry is very uneven when the stipple coat has turned, hollows in the masonry may then be dubbed out but the dubbing out coat should at no time exceed 15mm. The dubbed out parts should then be scratched to provide a key and allowed to dry and turn. The first, second and third coats are then all as for plaster on to lath, however, where a very fine finish is not required on the wall, the second coat may be finished up as the final coat and reworked after the initial set to produce the finish desired.

## GENERAL

The work in progress of plastering and the finished work must be protected against excessive heat or excessive cold or from draughts of air which would result in uneven drying out, which would cause cracking. It may also be necessary to keep the finished work hydrated with a fine, mist spray applied occasionally until the plaster has turned.

## SAND GRADINGS

### Ideal Grading for:

Sharp Medium Sand (A)	<b>Size mm</b>	<b>% Passing</b>
	2.36	100
	2.00	98
	1.25	88
	1.0	83
	0.63	70
	0.4	52
	0.315	42
	0.2	25.5
	0.125	10
0.075	0	

	<b>Size mm</b>	<b>% Passing</b>
Sharp Coarse Sand (B)	3.35	100
	2.0	95
	1.25	85
	1.0	81
	0.63	68
	0.5	60
	0.4	51
	0.315	41
	0.2	25
	0.125	10
	0.075	0
	Sharp Fine Sand	1.00
0.6		40 -100
0.3		5 - 70
0.15		0 - 15
0.075		0

## **E GENERAL SPECIFICATION FOR NHL (NATURAL HYDRAULIC LIME) RENDERS FOR INTERNAL USE**

### **1.00 PLASTERING TO WOOD OR METAL LATH**

#### **1.01 Wood Lath**

Woodlath may be either sawn or riven (split) typically 25mm to 32mm wide x 5mm to 6mm thick and in lengths of 900mm to 1500mm. Laths are fixed by nailing at each joist or stud and with joints in the lath working staggered in a break joint pattern. Laths should be fixed leaving approximately a 10mm gap between each lath. In setting out the break joint arrangement of the laths not more than ten laths should be joined as a group on a single support. The laths should be fixed using galvanised or non ferrous nails.

#### **1.02 Metal Lathing**

Metal lathing needs to be of the high rib type, nailed to every joist or stud, in accordance with the manufacturer's instructions and fixed with overlapping joints. The lath rib needs to be selected to suit the joist or stud spacing and the installation needs to be firm enough to take the pressure of the application of the first coat of plaster.

#### **1.03 First Coat of Plaster**

The first coat of plaster on either wood or metal lath should be applied at 10mm to 15mm thickness to give 8mm to 10mm cover on the lath and pressed in so as to form a key at the back of the lathing. It is advantageous to soak the laths in lime water before fixing to reduce the risk of rapid drying of the first coat.

### **2.00 THREE COAT WORK ON WOODEN OR METAL LATH**

#### **2.01 Wood Lath**

Wooden lath which has not been pre-soaked or has fully dried out needs to be well wetted in advance of the plastering so that the water has soaked in but is not surface wet.

#### **2.02 First Coat**

The first coat has to penetrate the gaps in the wood lath or through the apertures in the metal lath to form nibs at the back of the lath to ensure a good key. This first coat also has to provide sufficient bonding for subsequent coats and, therefore, needs to be well scratched after application, preferably by criss cross key pattern once the initial setting has taken place. The mix for the first coat on wooden lath is 1 : 2 - NHL 3.5 to sand and, on metal lath, 1 : 2 - NHL 5 to sand with hair added to the final mixing stage.

#### **2.03 Second Coat**

A second or undercoat should be applied two days or more (depending on atmospheric conditions) after completion of the first coat. If applied "green on green" the waiting period may be less subject to approval. The mix strength should be marginally less than the first coat. On wooden lath, the proportion is 1 : 2.5 - NHL 3.5 to sand, and on metal lath 1 : 2 - NHL 3.5 to sand.

#### **2.04 Finishing coat**

The mix proportions for the finishing coat, either on wooden lath backgrounds or metal lath backgrounds is 1 : 2.5 - NHL 2 to sand. For fine finished work a plain lime coat may be substituted for the third coat, of mix proportions 3 of lime : 2 of sand : 3 of lime : 1 of sand depending on the fineness of finish required.



### **3.00 PLASTERING DIRECT TO MASONRY**

#### **3.01 Background Preparation**

Ensure that the background is thoroughly clean. Cracks should be cleaned out and sealed with an NHL pointing mortar and allowed to cure for one or two days before plastering starts.

#### **3.02 Suction Control**

If necessary, apply sufficient water to reduce excessive suction, especially on bricks and porous stone. This should be done the day before, if necessary several times, with the last damping before application starts. Apply water starting at the top of the structure. Old bricks require more water than new ones. The top of the structure will dry out before the bottom. In base coats this means that scouring back and keying of the lower section might have to be done later than the upper section. Always dampen areas before applying next coat.

#### **3.03 Dubbing Out**

On defaced surfaces or in areas with a large amount of damaged joints, it may be necessary to apply a dubbing out coat to provide a level surface. When a dubbing out coat is used, let it set sufficiently (8 to 10 hours) before smoothing it and keying it. Allow to cure for approximately two days (more if very deep recesses have been filled) depending on weather conditions affecting the drying out time before proceeding with subsequent coats. The dubbing out coat may be applied by casting on.

The final thickness of this coat may be 3mm to 4mm from the surface of the deepest hollow filled or enough to allow levelling out and keying, but never more than 12mm in a single coat. The strength should, as always, be compatible with the type of background but a strong mix is recommended (1 : 1.5 or 1 : 2) using the correct NHL strength as specified.

#### **3.04 Repointing Before Plastering**

Where the old pointing is loose or the joint recesses are deep repointing will be required with the same type of mortar used for the base coat. Deep recesses should be made up with packing stones where necessary.

#### **3.05 Scouring Back and Keying**

Scouring is undertaken once the plaster coat is firm but before it dries using a cross grained wooden float. It must be done vigorously, efficiently and evenly in circular motion. It may be repeated as necessary before the plaster dries. Provide adequate keying between background and base coat and between each coat. Close criss cross patterns are much preferred to combining, but, where combining is used it must be in a wavy pattern.

### **4.00 THREE COAT WORK ON MASONRY BACKGROUNDS**

Background preparation, suction control and dubbing out keying will be required as set out in the General Specification.

#### **4.01 Stipple or Scud Coat**

This coat may be cast or sprayed on. The mix proportion shall be 1 : 1.5 - NHL 3.5 to sharp sand. Leave as cast for two to four days depending on weather conditions.

#### 4.02 First Coat

The first coat has to provide sufficient bonding for subsequent coats. A trowelled scratch coat is preferred on old bricks or soft surfaces. The mix for the first coat is 1 : 2 - NHL 3.5 hydraulic lime to sand. On soft or weak backgrounds 1 : 2 - NHL 2 to sand. The weaker mix may be approved after inspection. The thickness of the first coat depends on the nature of the background but will normally vary between 8mm and 12mm. Scour back and key (criss-cross keying preferred) once initial setting has taken place.

#### 4.03 Second Coat

The undercoat shall be applied two days (or more, depending on atmospheric conditions) after completion of the first coat. If applied "green on green" the waiting period may be less subject to approval. The mix strength should be marginally less than the first coat. Thickness may vary according to the background but shall not be less than 10mm but generally 15mm thick, and not greater than 20mm thick. Thicker undercoats will require a longer curing time before application of the next coat.

#### 4.04 Finishing Coat

Mix proportions 1 : 2 - NHL 3.5 to sand. Coat thickness shall be 5mm maximum for smooth or light textured finishes.

For fine finished work a plain lime coat may be substituted for the third coat, of mix proportions 3 of lime : 2 of sand : 3 of lime : 1 of sand depending on the fineness of finish required.

Sand for finishing coats shall be single sourced and set aside for that purpose, especially if no colouring is used. The mortar should be weaker than the one used on the base coat. It may be applied after three to four days from completion of the base coat, however, this period may vary a lot and could go up to seven to ten days, depending on the weather conditions.

### 5.00 MEASURES COMMON TO INTERNAL PLASTERING

#### 5.01 Curing

Check for light shrinkage during the first twenty-four hours. If this occurs apply light water mist on the relevant area or through hessian cover where provided. Repeat the operation, if necessary, the same day or the next.

#### 5.02 Smooth and Light Textured Finishes

Use finer graded sands, 2mm down to 75 microns for these finishes. Add just enough water to obtain required workability since the more water is added the higher the risk of shrinkage. Do not use lime putty additions as this will increase the shrinkage potential.

When mortar is firm enough to accept wood float, proceed to floating up in small circular motions as long as necessary to obtain required finish.

This is a most important phase of the finishing work and should be done diligently and energetically. The surface should not be floated up again to avoid tearing or patches. Curing and protection precautions are vital to obtain a good finish.

#### 5.03 Application of Coats

All coats must be applied firmly to exclude air and any excessive moisture. Surfaces must always be dampened before applying the next coat. Finishing coats may only be applied when the undercoat is adequately firm, which may take several days.

#### 5.04 Ensuring a Uniform Surface

To achieve a uniform surface, fix vertical timber battens on the wall at 2m to 2.5m intervals. If the wall is uneven use spacers and check that battens are straight with a plumb level. Screed off excess mortar between battens with a wooden straight edge spanning between the battens. When battens are taken down fill in strips with the same mortar. An alternative is to make running screeds 10cms. wide at regular intervals using the battens as described above and applying the undercoat in between them. Scour back and key as usual after initial setting. Check for shrinkage during the first two days and, if necessary, lightly dampen the affected area, scour back and re-key. In the case of intermediate coats this will apply to each coat.

#### 5.05 Protecting NHL Plasters

The setting properties of NHL mortars require the following protection:

<b>Mortars made with of:</b>	<b>Protect from frost, rain, strong wind or direct sun for minimum</b>
NHL5	48 Hours
NHL3.5	72 Hours
NHL2	96 Hours NHL

The preferred form of protection is damp hessian cover which, with re-dampening, could also, in some cases, contribute to curing the mortar in plasters.

Work should not start in frost conditions or with temperatures below 5° centigrade generally but, when working with NHL 2 or in plastering with fine finishing coats, when the temperature is below 8° centigrade.

Protection from drying air currents, particularly in hot weather must be provided.

#### 5.06 Storage of NHL in Bags

The bags of lime shall be stored off the ground (e.g. on pallets) in a weatherproof well ventilated store. Naturally Hydraulic lime produces a set when mixed with water and therefore must be kept dry until use.

#### 5.07 Mixing of Mortar for Plastering

A normal mixer (used for general mortar mixing) may be used. First introduce half of the sand, followed by all of the lime for the mix. After two to three minutes mixing (dry) add the remaining half of the sand. Add the water slowly until workability is achieved. Mix for twenty minutes minimum, or longer for improved workability with less water. (The less water used to achieve the desired workability the less shrinkage in the finished work).

#### 5.08 The Use of Hair to Reduce Shrinkage

Hair of approved type from a specialist supplier may be added to the plaster undercoats to increase tensile strength and reduce shrinkage cracking. The use of hair in the first coat applied to lath is generally to be recommended. Hair added to the mortar at the end of mixing, needs to be teased out and added in a continuous operation to ensure even distribution. Quantities of hair to be added to the mix are 7.5kg per cubic meter of mortar for use on lath and 5kg per cubic meter of mortar for general use.

## **6.00 SANDS FOR INTERNAL PLASTER**

### **6.01 Sand**

Sand used for first coat in all applications will be sharp, coarse, i.e. 3.35mm down to 0.075mm grading. Sands for use on second coats on metal lath, soft bricks to medium bricks and masonry shall be either sharp, coarse or sharp, medium. Sharp, medium grading is 2.36mm down to 0.075mm. Sands for finishing coats shall generally be sharp, fine, i.e. 1.18mm down to 0.075mm.

### **6.02 Health and Safety Relative to the use of Lime**

Dry bagged lime and lime mortar is caustic and can dehydrate the skin. When using lime it is advisable to wear gloves and protective overalls and goggles, and if working with lime for prolonged periods, to protect exposed parts of the body with a barrier cream. A dust mask should be worn when handling the dry lime from the bag and from bag to mixer or in any situation where lime dust may be released.

# APPENDIX IV

## **THE ROUGH GUIDE**

A summary of conservation theory  
and a basic guide to working with  
lime

### **Further reading**

## THE ROUGH GUIDE

**A summary of the proper approach to conservation**

+

**A very basic outline of the use of lime in masonry repair**

+

**Some further reading**

### **DO Take the right approach**

- You are not just 'fixing' or 'improving' an object or a building. You are **prolonging the life** of something that is of historic value and that is still doing the job it was made to do.
- **Allow a little more time** for everything - recording, preparation, ordering material, getting rid of vegetation etc. You may also need to allow time to get permission or consent.
- Make sure that what you propose to do is **permitted** by legislation. The area office will have this information and will prepare dossiers for each site. When in doubt, consult. Remember that it is not always possible to undo the damage caused by a wrong action.
- If in doubt about any matter, **consult with others** - you do not have to take decisions by yourself. The best approach is to have a worksheet agreed by your team saying what needs to be done, the materials you need and the methods to be used.
- Remember to **make a record** of the work, take photographs before as well as after. Add a report on the work to the dossier when you finish.

### **DO Follow the Good Practice Principles**

- Only do the **minimum** necessary
- Use the correct **materials and methods** that are tried, tested and sympathetic to the feature or building
- **Respect** previous alterations of quality and consider carefully before removing anything just because it is not original
- Carefully **examine and survey** before deciding what to do
- What you do should be **reversible** where at all possible

**DO Inform yourself**

- Be willing to go on a start-up, hands-on course in lime. As you begin working with lime, you will probably want to learn more and attend more advanced workshops
- The other sections of these Guidelines contain more detailed information and Technical Specifications (Appendix III) to which you can refer.
- There is very good background reading available, written by Irish practitioners and listed in Further Reading in the following section. Waterways Ireland district offices will stock these books for reference.
- Some of the lime suppliers have websites with excellent data sheets which can be printed off. Most of the suppliers will advise on their products and will call out to site to advise on their products.

**DO Follow Health and Safety advice from Waterways Ireland**

- Waterways Ireland will have its own safety protocols
- Scaffolding is often an element in masonry repair and pointing
- Note that lime needs to be treated with more caution than cement.

**DO Make sure you use the correct Materials and Methods**

- Never use cement.
- Never use plasticisers or anti-freeze or any other additives in the mixing water.
- Choose the lime type and strength.
- The sand quality and grade is important

**Commonly used lime types**

Hydraulic lime sets on impact with water. It is a powder sold in bags and comes in strength grades NHL 2, 3.5 and 5.

Fat lime or lime putty sets by carbonation - contact with air. It comes in tubs and is like a thick yoghurt.

There are other types of lime such as hot lime described in Technical Specifications (Appendix III) but knowledge and experience are essential and there are safety issues in its use.

**Sand**

The common description of good sand is sharp, clean and well-graded. The suitable sand grading is decided by where it is to be applied and by the size of the joints in repointing.

Generally, the sand available for modern construction - blocklaying etc. - is too fine for use with lime for pointing. Sand for lime mortar uses a coarser aggregate typically from 3.35mm or 2.35mm down. The technical specifications (Appendix III) go into some detail on this. For very fine joints as in some ashlar or snecked masonry, a fine silica sand may be necessary.

The best advice here is to discuss the project with lime supplier who will also supply sand. Get the properly graded sand for the specific job supplied with the lime. Quantities of sand for repointing are small so there will be very little added cost compared to using a local source. In time, and with experience, you may source a suitable sand locally.

**Water**

Clean enough to drink , no additives.

**Pinnings**

Small stones of various sizes and shapes and broken slate of various thickness used to insert into thick joints. It is handy to collect the pinnings from the mortar being raked out so do use a ground sheet or board along the foot of the wall to avoid small stones being walked into the ground.



## DO Use the Right Lime Mix

### **Lime mortar is sand mixed with a setting/binding agent which is lime.**

The theory is that the lime fills all the spaces between the grains of sand and binds them together. In a well-graded sand (which you can order from the lime supplier) the voids are about 30 to 35%. This gives a mix of 1 lime : 3 sand. There is a simple but fussy way of measuring the actual voids in a batch of sand but the advice is to rely initially on the supplier who will know the sand (but who might tend to lean towards a slightly richer mix).

Details in Appendix III Part A

### **Normal mixes 1: 2.5 to 1: 3 mixed with as little water as possible**

#### **What lime to use where**

Specifying mixes is a matter of knowledge and experience. Many factors come into play depending on the circumstances.

The mortar must always be softer than the stone. So a mortar that can be used with a strong limestone may be too hard for a soft sandstone or old brick. The lime grade decides the hardness of the mortar. The best choice is the softest mortar that is strong enough for the job.

The grading of the sand is also important and is decided by where it is to be applied and by joint thickness.

This is a rough guide to lime grades for pointing. Check the previous section Appendix III for more detail

#### **Lime**

NHL 5	Pointing walls in contact with water or where structural strength is required such as in bridges
NHL 3.5	Usually for general purpose pointing
NHL 2	Pointing a soft stone or brick.
	Internal plastering with hair or polyester fibre added for scratch and float coat Internal finishing coat with a fine sand such as a silica sand
Lime putty	Usually for internal plastering with hair or fibre added for reinforcement.

## DO Mix it Properly

- Be careful with measuring quantities
- Never use a shovel. It is not accurate enough.
- Use a bucket or other container with volume marks.

**Use as** little water as possible. Stiffer mortar works better.

Lime mortar must be mixed very well. If using small quantities, mixing by hand on a clean base is fine but work it for longer than usual.

When using **NHL**, a standard drum mixer will do but it should mix for longer than for cement-based mortar.

Mix as follows:

- Add 1 part sand to the dry mixer.
- Add 1 part lime and start mixing
- Add remainder of sand, usually 1½ to 2 parts (according to the sand grading)
- Mix dry until colour is consistent
- Add water very slowly until correct consistency is reached. Err on the side of a drier mix.
- Mix for a minimum of 20 minutes after addition of water
- As the mortar continues to mix, it will become more 'fatty' or workable

When using **NHL**, a standard drum mixer will do but it should mix for over 20 minutes

When using **lime putty**, a standard mixer does not work well. Good lime putty mortar is made using a mortar mill. However, it is possible to buy lime putty mortar pre-mixed in a tonne bag. As long as air is totally excluded from the mix, it can be used straight from the bag without having a mixer on site. The remainder can be sealed again and stored for future use. This mix is most often used for internal plastering when it can have reinforcing hair or fibre added at mixing stage.

Note that polyester fibre functions as a modern substitute for animal hair and costs a lot less.

**DO** Make sure you have the correct tools for working with mortar

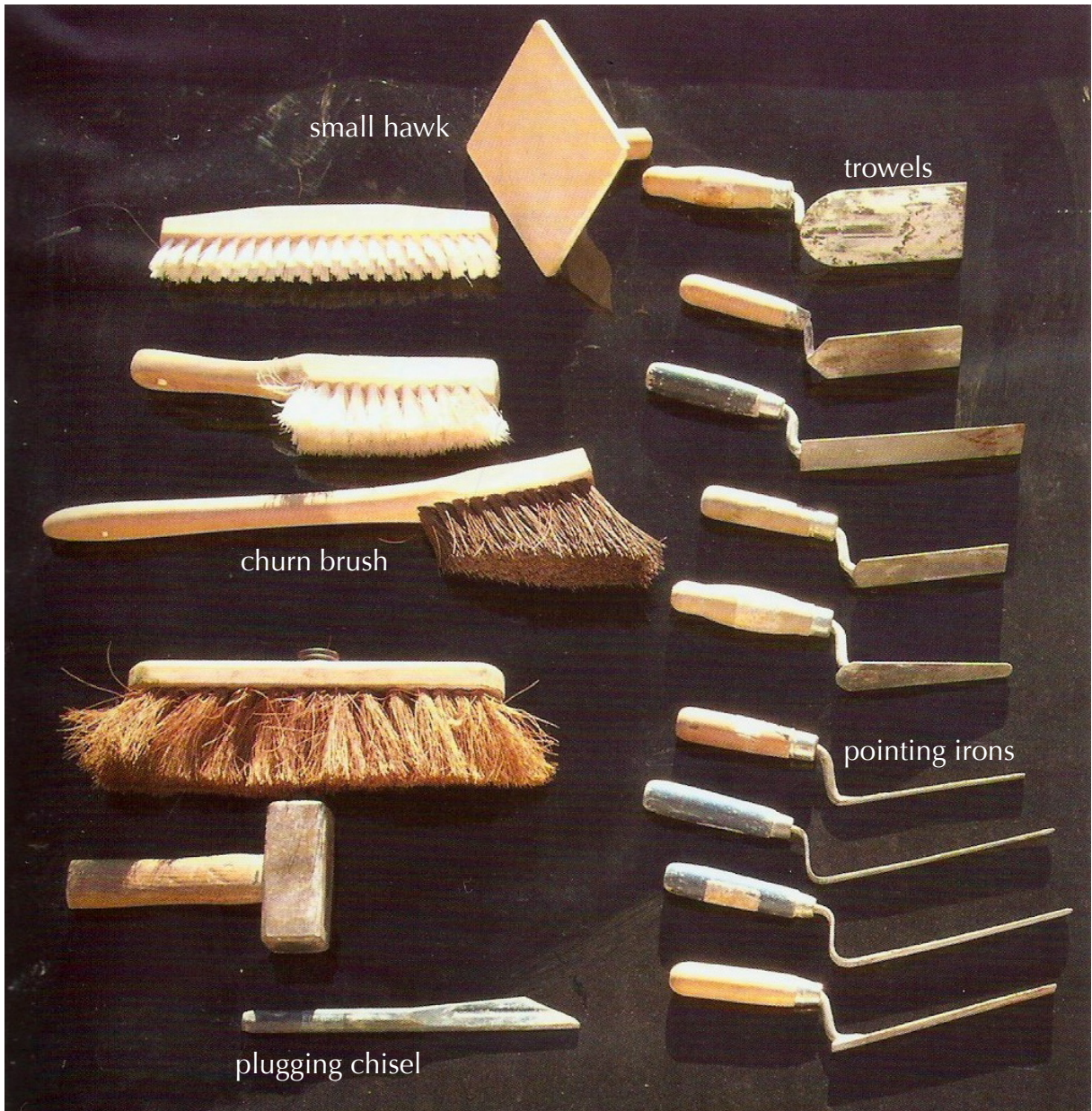


Image courtesy of P. McAfee

Brushes for cleaning joints  
Churn brush for 'beating back'  
Lump hammer  
Plugging chisel

Small hawk  
Range of trowels  
Range of pointing irons

**Never** use an consaw, disc or angle grinder to remove mortar

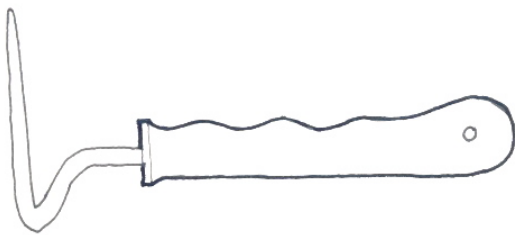
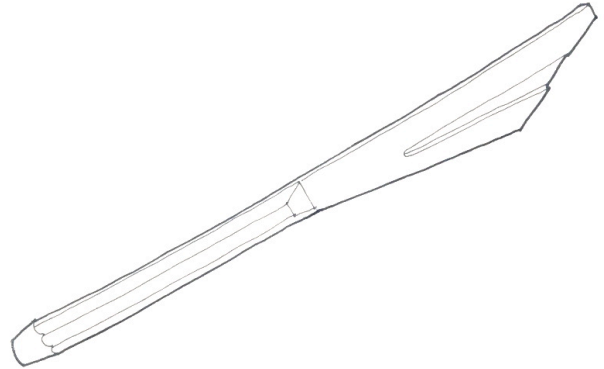
**Never** use a wire brush on stone. If a stiff bristle brush is not sufficient, use a bronze brush to clean stone.

## Tools for Removing Mortar

### Raking out

- plugging chisel
- lump hammer
- hooks (various)
- hacksaw blade
- drill
- brushes
- ground sheet

The **plugging chisel** has a narrow blade and will suit many joint thicknesses. It is used with a lump hammer and the narrow tip gets in behind the mortar being removed. It is far more suitable than a cold chisel or bolster



If joints are too tight to use the plugging chisel, **hooks** like this **hoof pick** will prove useful for removing mortar. Other shapes of hooks can be easily made from stainless steel bars of various diameters, bent at the end and ground to a point like an elongated meat hook

On very fine joints such as ashlar or snecked masonry, a **hacksaw blade** may be the only practical implement. It can be set in a wooden handle for ease of use

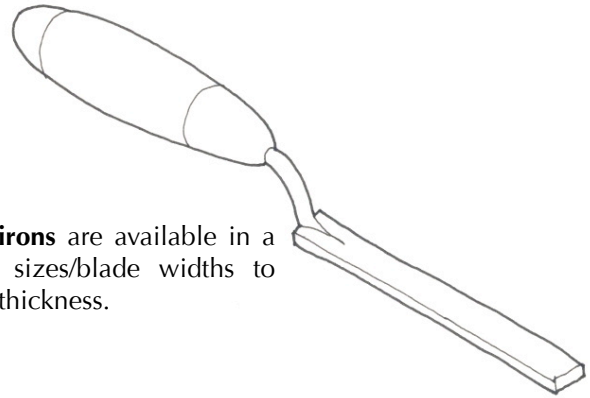


**Never widen the joint.** This is known as pitching and was previously carried out on masonry with fine joints, leading to greater problems than those it was intended to solve.

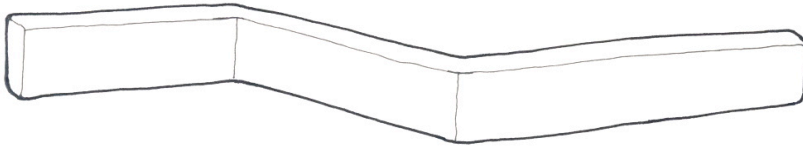
**Cement pointing** may be loose and easy to remove as it was often not inserted to the proper depth. If it is hard and solid, removal will damage the stone and is probably best left. If there are some solid patches of cement mortar, holes can be drilled in at close intervals at right angles to the wall to break up the mortar and the plugging chisel used. An electric drill is the only power tool that should be used.

### Tools for Pointing

- small hawk
- pointing irons or jointers
- handheld spray bottle



**Pointing irons** are available in a range of sizes/blade widths to suit joint thickness.



Many experienced craftspeople prefer to have **purpose-made pointing tools or jointers** made from steel bars in a variety of widths. The bar is cranked to allow knuckle space.

**NOTE** The commonly used triangular pointing trowel is not very suitable for this type of pointing



A **spatula** is a tool useful for fine work and often used by plasterers to repair mouldings etc

### Backfilling

- rammer
- wide lath to suit joint thickness

There are tools available for compacting the mortar in the joint as it is applied in stages. These are a steel flat welded to a bar to form a T-shape. However, most will find it more useful to use a wide timber lath to suit the joint thickness

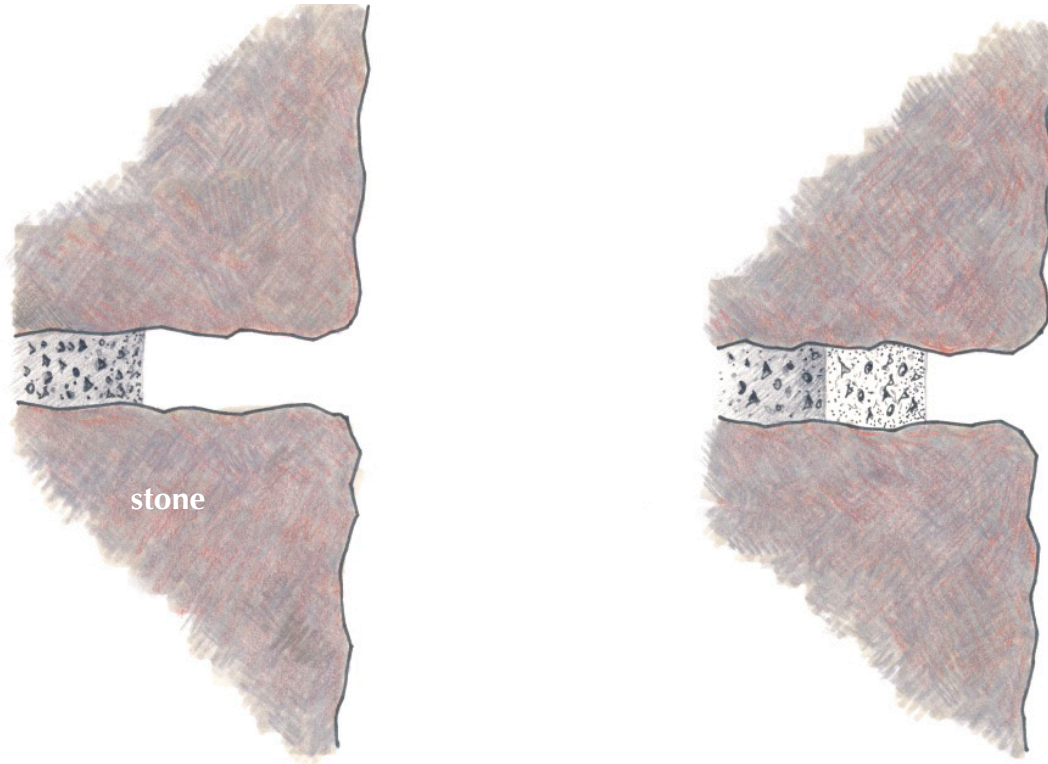
### Finishing

- churn brush to 'beat back' and compact the mortar
- rounded tool (where joints are fine) to press mortar back

### Aftercare/Protection

- hessian
- spray
- plastic sheet to protect from rain (maintain a gap to wet mortar)  
or
- foil-backed fibreglass roll in cold weather (fibreglass side in)

## Repointing step-by-step

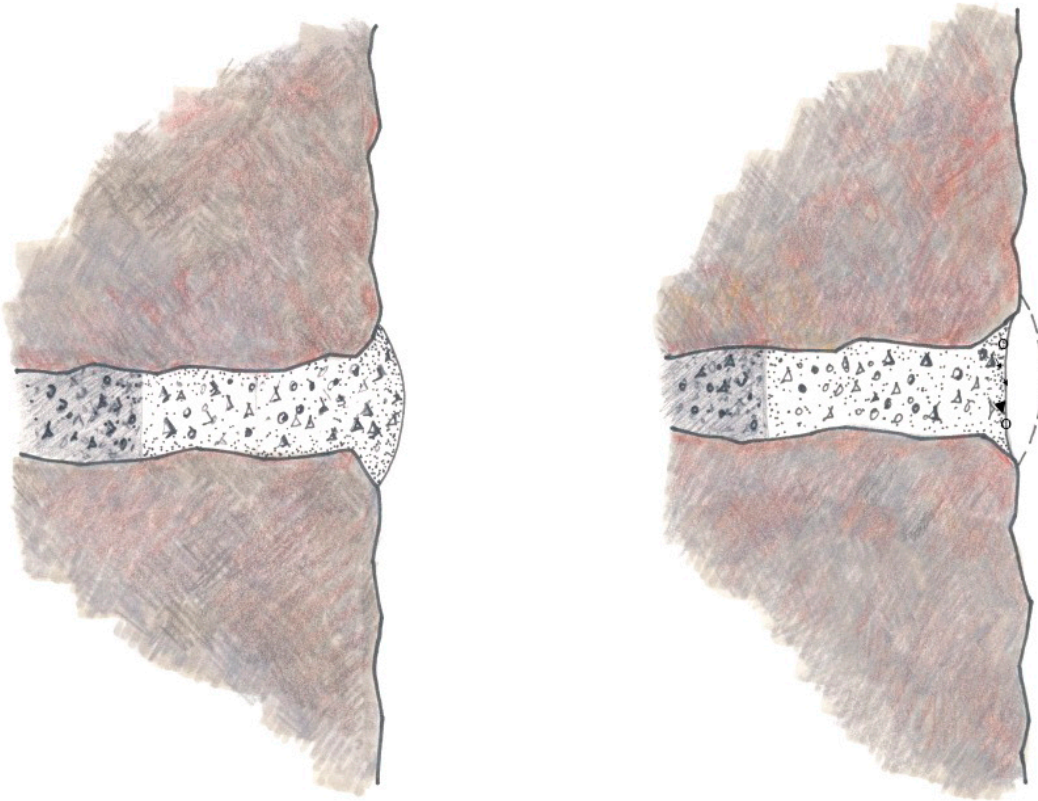


### Rake out and clean joint

- Remove any vegetation and humus
- Rake out using the correct tools to suitable depth =  $2\frac{1}{2}$  times joint thickness i.e 20mm joint is raked out to 50mm
- Remove all loose material with soft brush
- Flush out with water (from top down) to clean joints and ensure no dust or debris remains. Do not use a power hose as this may flood the wall core.
- Leave for 24 hours before pointing to ensure that no water is lying in the joints.

### Backfill

- Dampen joint by light misting by handheld spray bottle
- Begin to fill joint in steps of 20mm maximum
- Compact mortar by ramming it back to compress into joint with pointing tool
- If joint is deep, use rammer tool or timber lath



### Fill joint

- Dampen (but not wet) joint before each application.
- Fill joint in steps of 20mm thickness.
- Allow each application to take a set before applying next layer of mortar.
- Leave final application slightly proud of face of stone for beating back
- If joints are big and wide, apply pinnings to reduce size of joint
- Protect mortar at each stage as in Finish and Aftercare

### Finish and Aftercare

- Allow mortar to take on a good set
- Finish by beating back with stiff bristle brush, striking joint at right angles to face of wall. Press rounded edge of pointing tool or bar for fine joints
- Beating back or 'tamping'
  - compresses the mortar
  - exposes aggregate in the mortar
  - exposes the edges on the stones
- Protect from sun, wind, rain, danger of frost to allow for slow setting. Use hessian kept damp by spraying. Maintain gap with wall. Add foil-backed fibreglass roll in cold weather. Allow for 7 days protection for NHL, more for lime putty



Pointing using pointing tool and small hawk

Image courtesy of P. McAfee



Inserting pinnings in large joints and tapping in

Images courtesy of P. McAfee



A good example of new pointing repair with pinnings. Joint beaten back to compact mortar, expose aggregate and stone edges. Note the good match with the older pointing on bottom left



## FURTHER READING

### **Irish Stone Walls**

History, Building, Conservation    **Patrick McAfee**

### **Lime Works**

Using lime in Traditional and new buildings    **Patrick McAfee**

### **Stone Buildings**

Conservation, Repair, Building    **Patrick McAfee**

**Stone by Stone** Patricia Warke, Bernard Smith John Savage Joanne Curran Dawson Stelfox  
**A Guide to Building Stone in the Northern Ireland Environment**

**Advice Series** [www.ahg.gov.ie/heritage-publications](http://www.ahg.gov.ie/heritage-publications)  
Order hard copy by email from [publications@opw.ie](mailto:publications@opw.ie)

**Maintenance** - A Guide to the Care of Older Buildings

**Ruins** - The Conservation and Repair of Masonry Ruins

**Bricks** - A Guide to the Care of Historic Brickwork

**Windows** - A Guide to the Care of Historic Windows

**Iron** - The Repair of Wrought and Cast Ironwork

**Energy Efficiency** in Traditional Buildings

**Work Practice Guidelines** <https://www.doeni.gov.uk/>

**Remedial Conservation Works on Scheduled Masonry Monuments October 2008**

**See Lime Suppliers websites** for general information

Useful Method Statements are available on [www.stonewarestudios.com/advice-centre](http://www.stonewarestudios.com/advice-centre)