HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Re-discovering Traditional Mortars in Scotland

HES research update

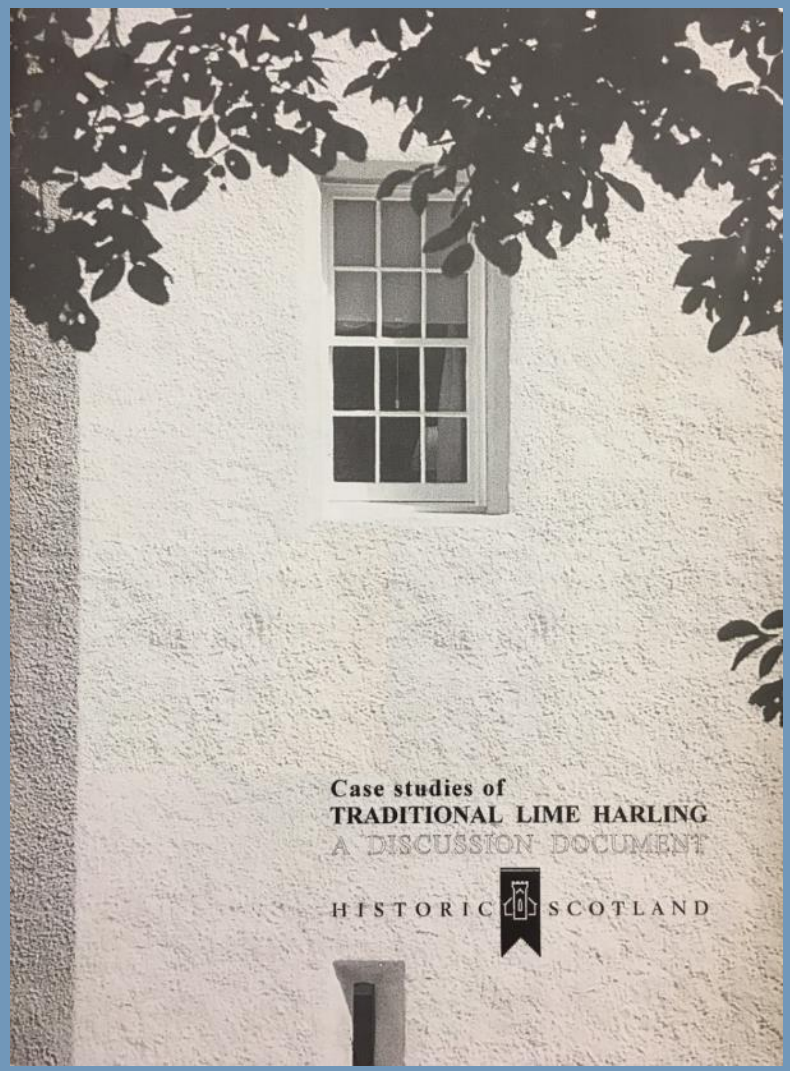
Jessica Hunnisett-Snow MRICS IHBC

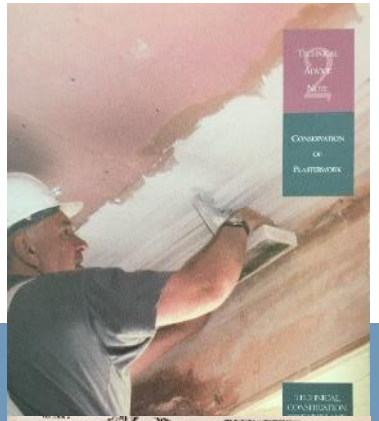
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

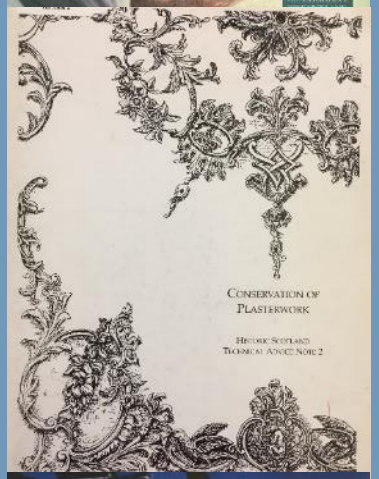
Background

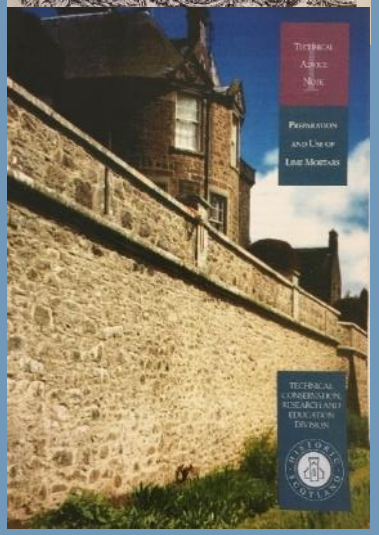
- Holyrood park Education Centre, Edinburgh (2014) Hot-mixed mortars workshop with practitioners
- Ecclefechen, Dumfriesshire (2016): BLF hot-mixed mortars seminar - set out HES's role and intentions with regard to research
- Edinburgh University (2017): Hot-mixed mortars seminar - introduced research streams
- June 2017: Memorandum of agreement with UK and Ireland heritage agencies to collaborate on research

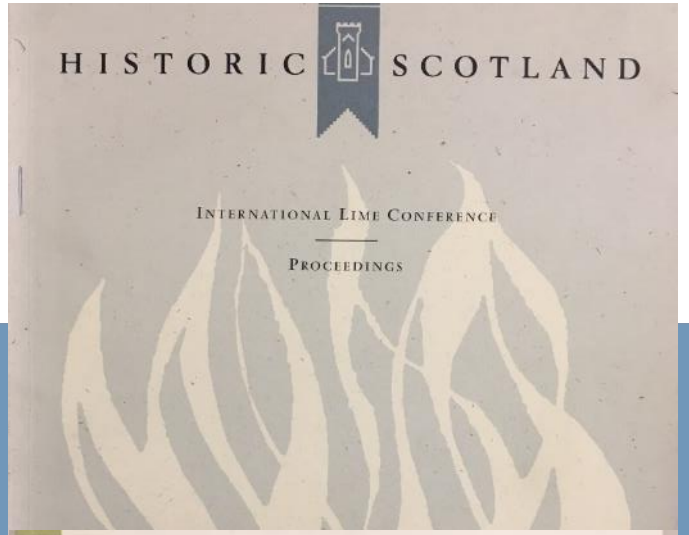
Past research and Guidance

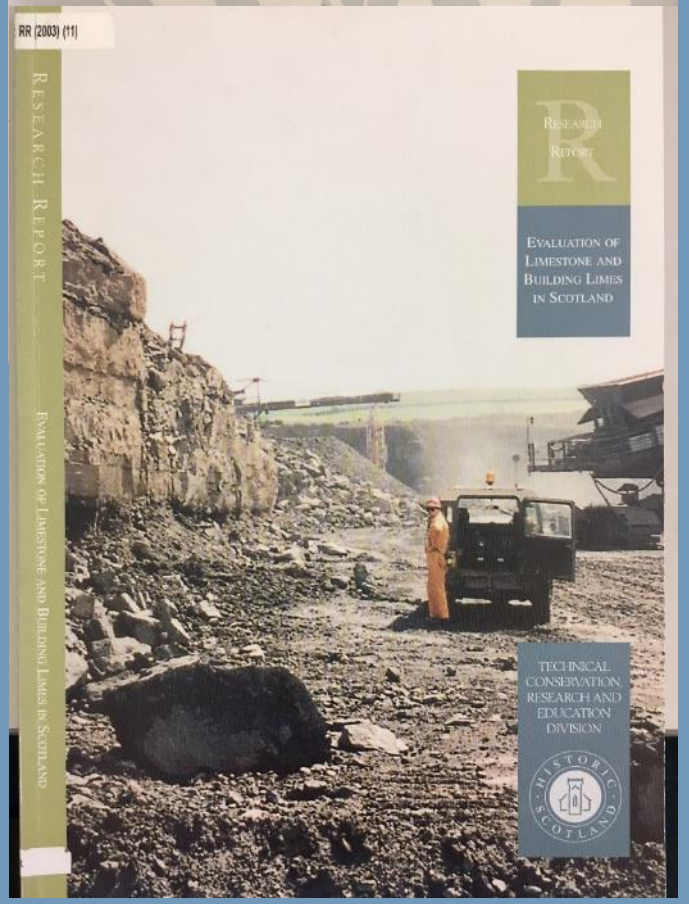












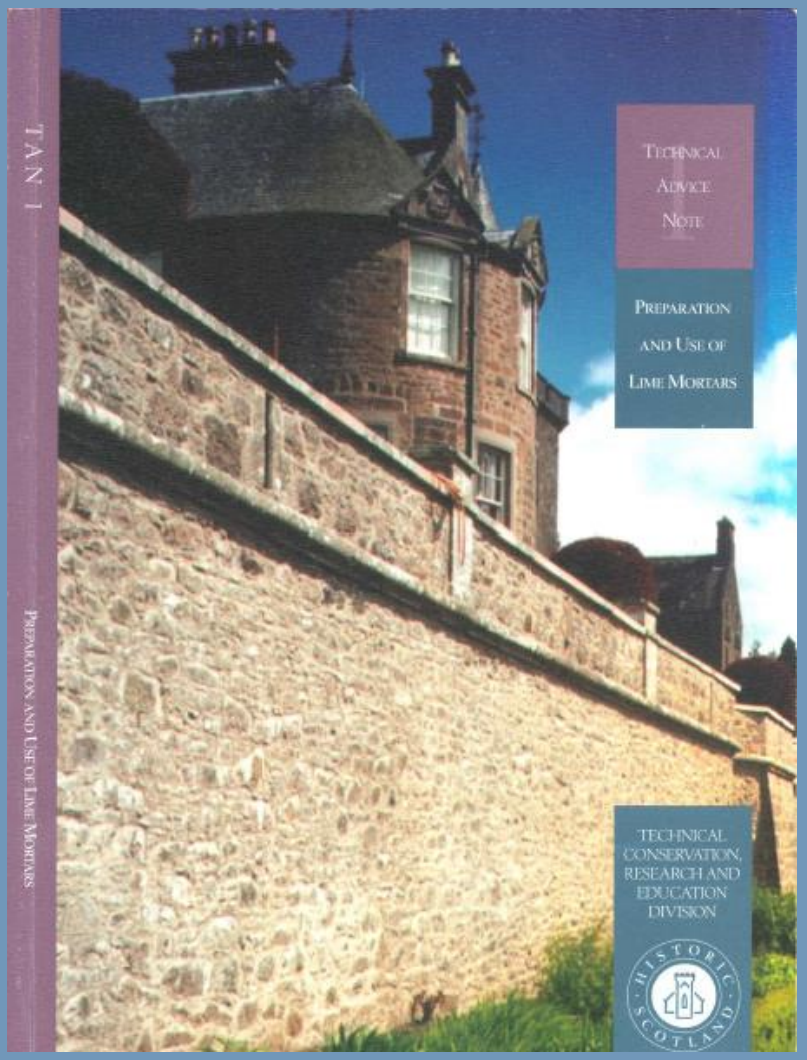
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Technical Advice Note 1: Preparation and Use of Lime Mortars (2003)

It is apparent from investigation of surviving traditional mortars that the majority were made from quicklime and sand, or from fresh roughly slaked hydrate and sand. Whilst these methods may not always be appropriate for use on modern building sites it is possible to purchase ready made mortars of this type from some specialist suppliers.

Traditional hydraulic lime mixes

Mortars based on moderately hydraulic quicklime and sand are common in traditional Scottish construction, and many of these mortars appear to have been used in general building work before any slower slaking lime had fully converted to calcium hydroxide. Close examination of traditional lime mortars from almost any historical period will show evidence of small unmixed balls of lime throughout the body of the mortar. These mortars may have been matured for a short period and used cold or they may have been used freshly made whilst still hot. Similar mortars are also frequently found as plaster undercoats and in harling.



HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Lime specification in Scotland - recent trends

- Clients require lime specifications
- Architects/surveyors seek advice from consultants
- Analysis of existing/historic lime mortars on site (cost)
- Analysis typically shows complex, lime-rich mortars with lime inclusions – hot-mixed
- **BUT** Specifiers and consultants suggest the use of 1:3 NHL mixes (typically moderately or eminently hydraulic)
- **OR** increasingly, ready-mixed, pre-bagged, NHL-based formulated lime products, with (sometimes unspecified) additives, often spray applied.

- Traditional hot-mixed mortars and earth/lime mortars confined to individual self-taught craftspeople and a few surveyors and architects – generally on the quiet!

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

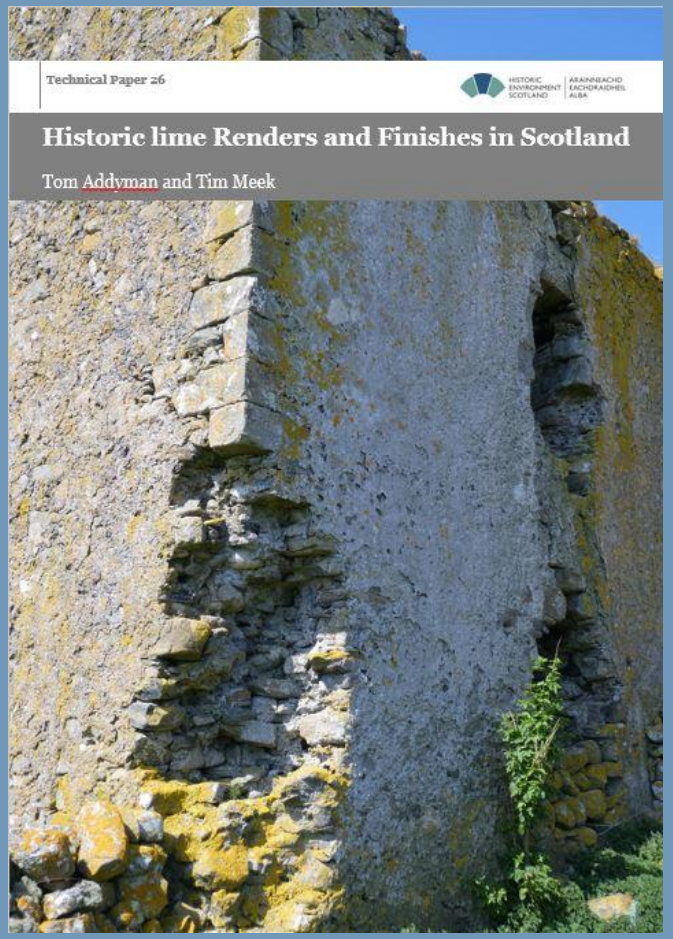
Forthcoming HES Hot-Mixed Mortars Technical Papers:

- The physical evidence - *what do the buildings tell us?*
- The microstructure- *what does mortar analysis show?*
- The scientific theory - *how-do they perform?*
- The archival evidence - *what do the sources say?*
- Modern case studies - *are they fit for purpose?*
- The route to specification - *how do we support their use?*

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

What do the buildings tell us?
Historic lime renders and finishes in Scotland

- Photographic survey and historic research in to the nature of surviving lime finishes
- 56 buildings inspected
- Dating from 13thC to 1920s
- Describe how to look for and identify early lime finishes
- lime-rich, durable, tenacious mortars
- Complex in appearance
- Locally diverse
- Under threat from being overlooked, covered over or lost



Historic lime renders and finishes in Scotland

"[the authors] have found that historic finishes, especially harling, and particularly those applied in the first quarter of the eighteenth century, are astonishingly robust.

External plaster and harl with lime washing, when applied to formal building types, are generally thin and sometimes…just a whisper over the surface of the stone; gently undulating and [often] lime washed.

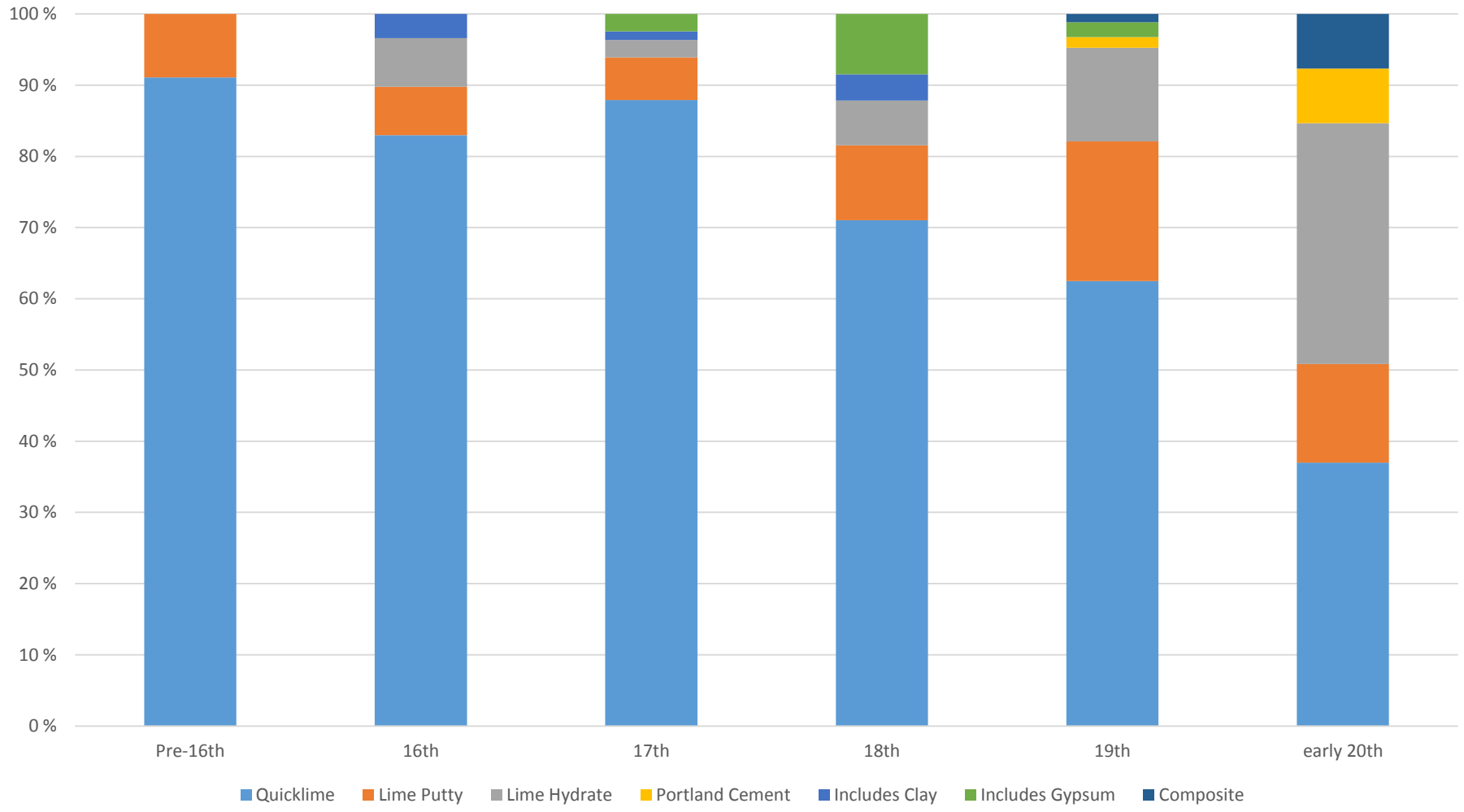
They provide seamless and seemly finishes to buildings, helping to inhibit water penetration and stone decay."

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

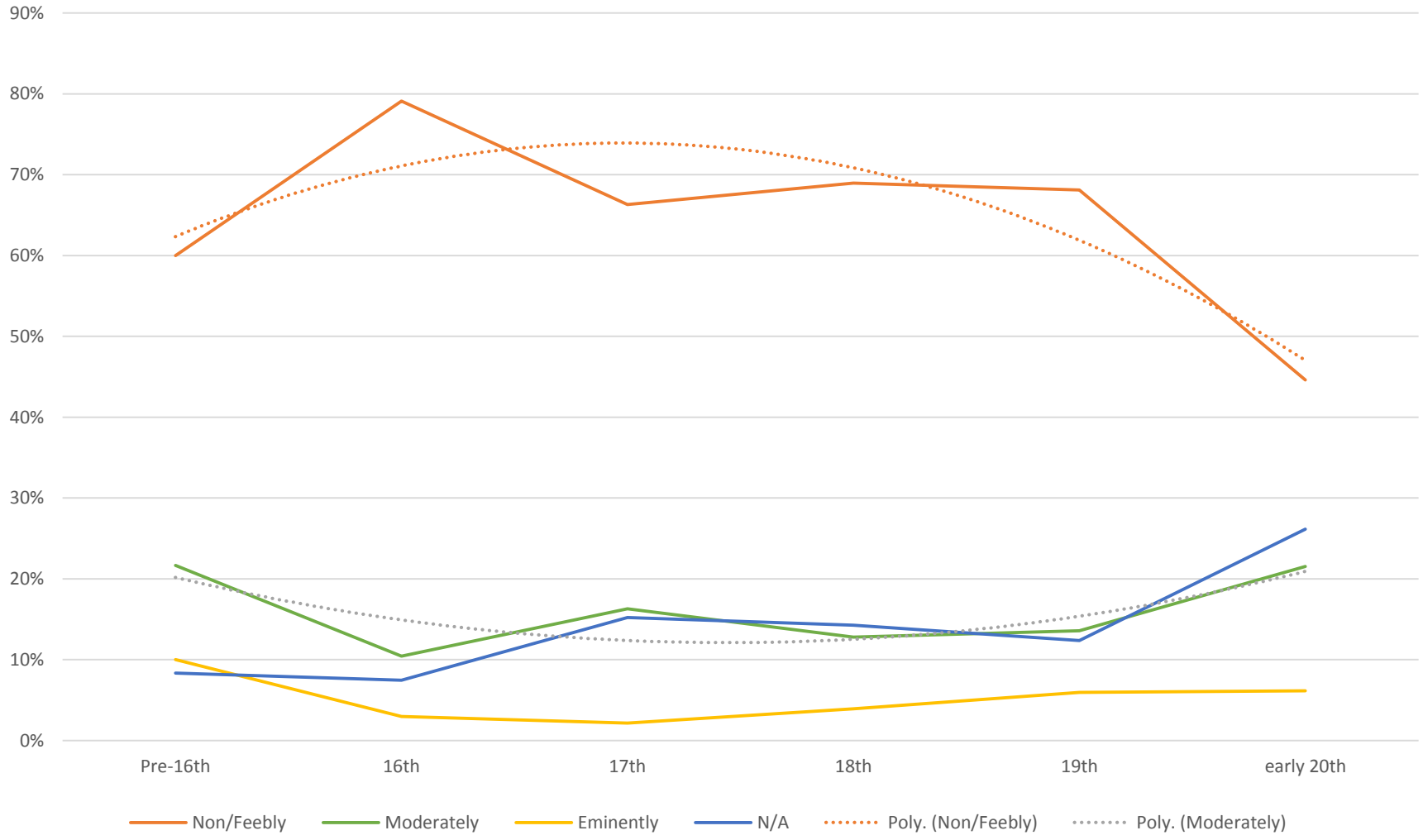
Mortar Analysis

- Analysis of >3000 samples held in the Scottish Lime Centre Trust database
- The spread and frequency of lime binders
- The lime to aggregate ratio
- The hydraulicity of the mortar
- significant additives
- The influence of region and climatic differences

Binder type use per century



Hydraulicity of mortar samples over time



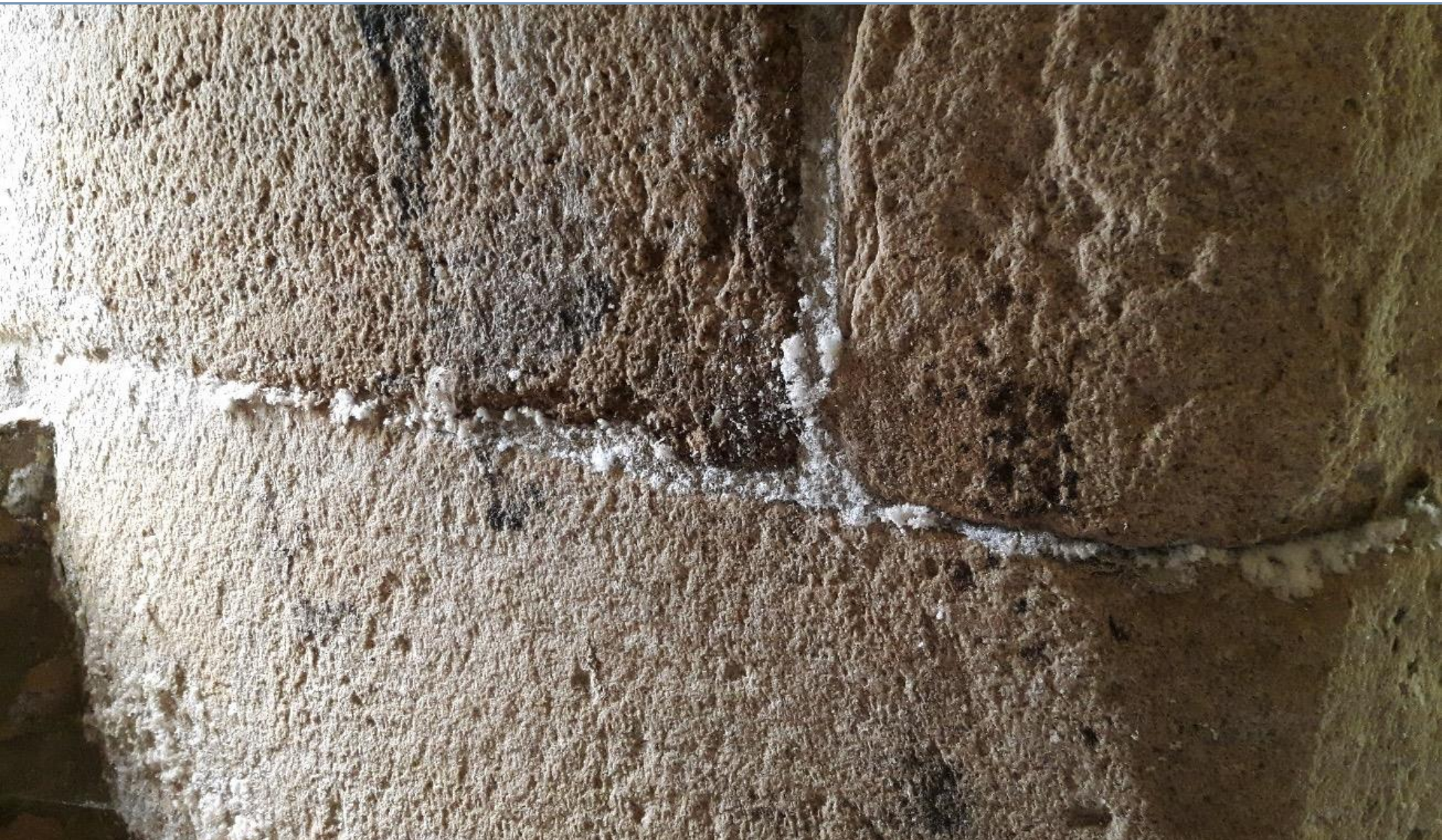
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

What does the science tell us?
Hot-mixed lime mortars: considerations on microstructure and functional performance

- Identifies the role of lime mortars in wicking away moisture (and salts) from the masonry substrate (sacrificial)
- Suggests lime-rich, non or feebly hydraulic quicklime mixes exhibit this function most effectively
- Suggests increasing hydraulicity and lower binder content result in a reduction in functional performance
- Concludes that hot-mixed mortars are the only practical means of replicating the historic mix-constituents at the historic proportions

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

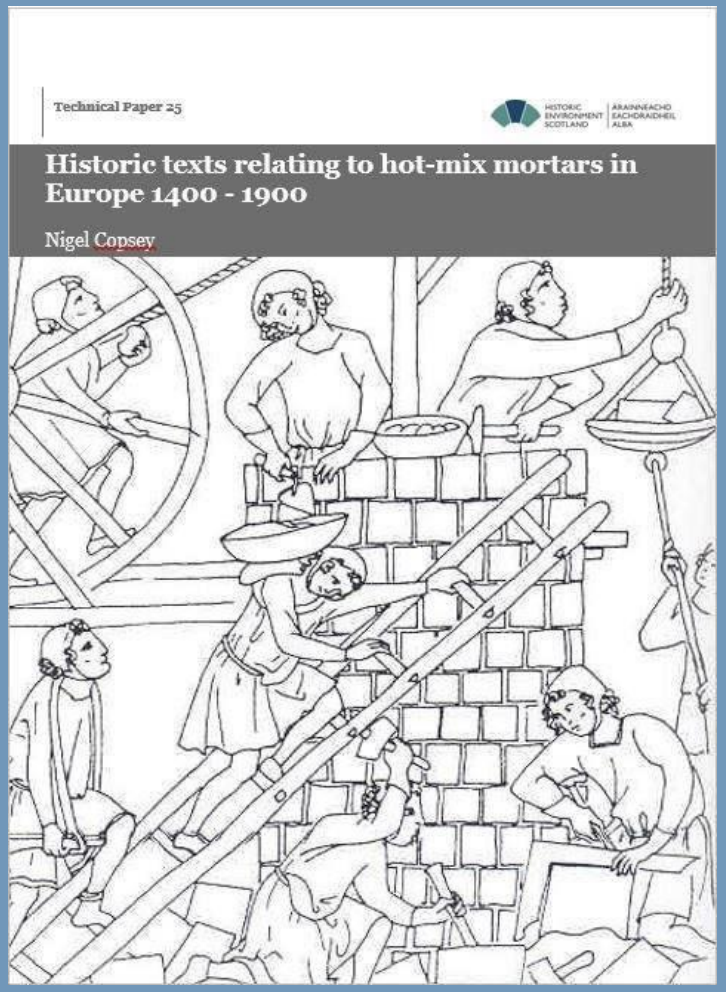
Sacrificial mortar: precipitation of salts at masonry joints



HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

What does the written evidence tell us?
Historic texts relating to hot-mixed mortars in Europe 1400-1900

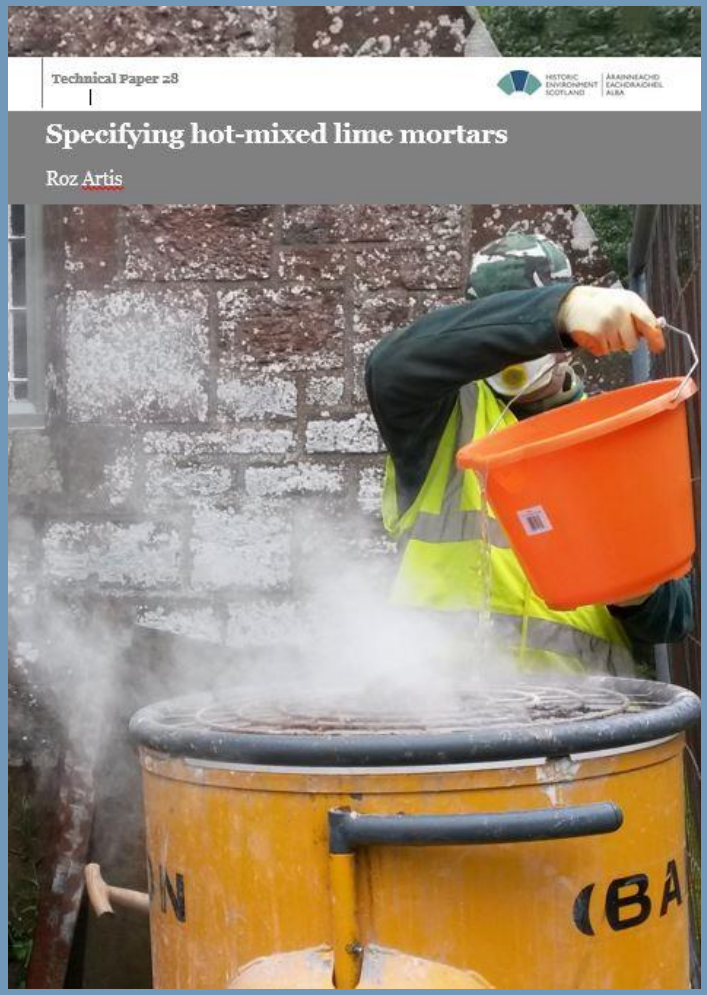
- Texts from 60BC – 1955
- 200+ extracts from European sources
- comprehensive review of existing literature
- Mortars were lime rich and hot-mixed
- Hydraulic lime binders not routinely used above ground
- Highlights the need for training



HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Specifying hot-mixed lime mortars

- Standards of specification in general are poor
- Specification of *all* lime mortars requires skill and understanding
- It is easier, and less risky (?) to specify a ready-mix
- Hot-mixed mortars are currently the preserve of a small (but growing) number of craftspeople and specifiers



Issues

Materials Sourcing

- UK sources of quicklime are hard-burnt
- Can lead to slow slaking - pitting /popping
- No Scottish sources of quicklime

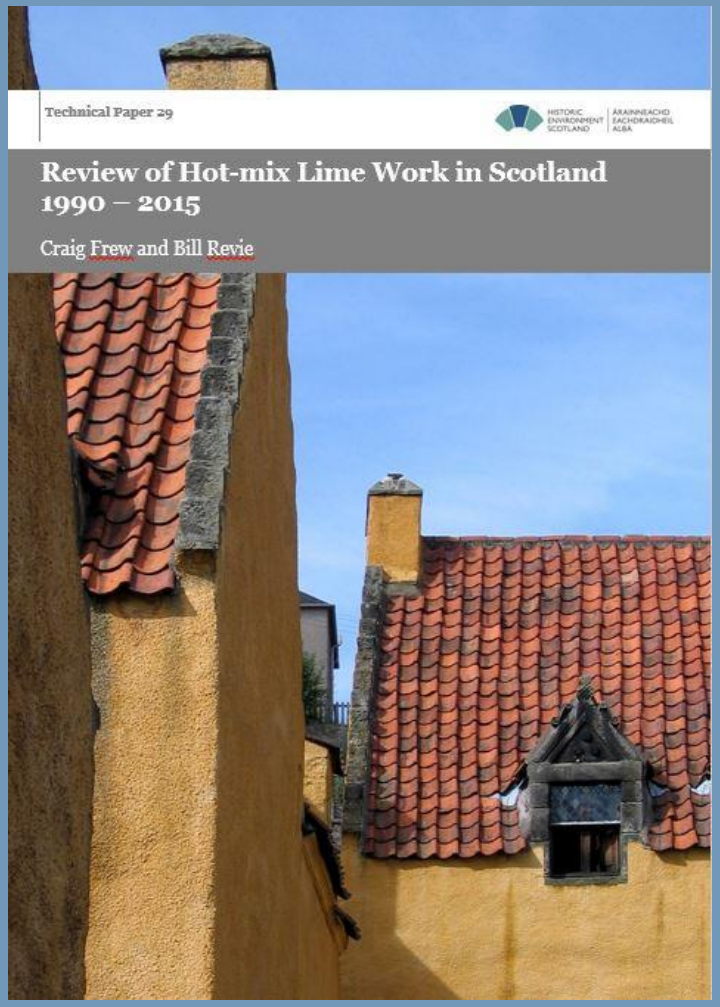
Health and Safety

- Quicklime is ‘hazardous’ and highly reactive

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Review of hot-mixed lime work in Scotland 1990-2015

- 25 examples of recent hot-mix work in Scotland
- 1990 -2015
- Quicklime and gauged mixes
- Traditional lime mortars are sacrificial – they will show up defects!
- Failures – almost entirely attributable to poor detailing.



Craigievar Castle, Aberdeenshire (work completed 2010)

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Historic Environment Scotland hot-mixed mortar site projects

- Gable wall, Sand Haa, Shetland
- Gable wall, Midcauseway, Fife
- Church building, Crawfordjohn, Lanarkshire
- Boundary walls, Dunbar, East Lothian
- Boundary Walls, Kinneil, Bo'ness
- Stable Block, Falkland, Fife
- Ruin consolidation, Balmerino Abbey, Fife

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Haa of Sand, Shetland, October 2014

- External repairs to 18th C Haa House
- Category ‘A’ listed building
- NHL gauged hot-mixed mortar with local aggregate and crushed shell
- Skilled local contractors
- Challenging weather conditions

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Haa of Sand – performing well three years on!

Kinneil House, Bo'ness (work under way 2017)

- Scheduled site
- 40m boundary wall
- Hot-mixed mortar
- Local sharp sand aggregateand crushed shell

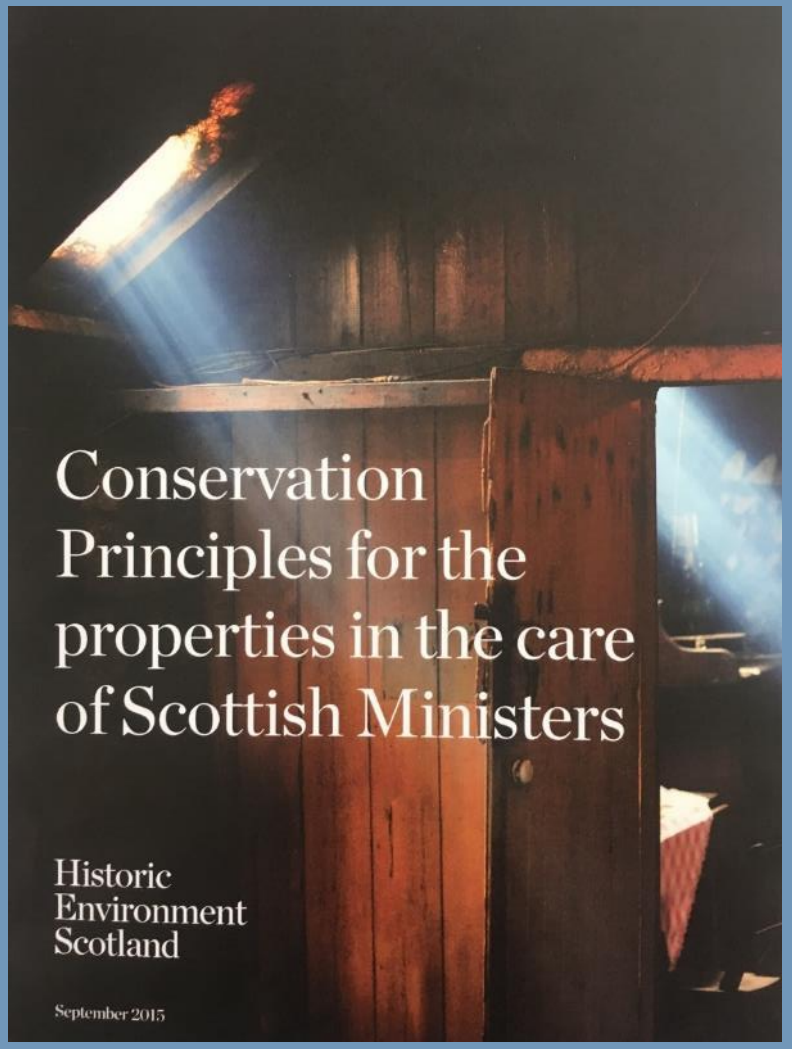
Boundary walls, Dunbar (completed 2017)

- Community group
- Re-building 20m rubble garden wall
- hot-mixed mortar, crushed shell,
- Winter working (Nov – Jan)
- Contractors new to hot-mixing
- Trainee labourers
- Hand-batching and mixing

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Historic Environment Scotland Conservation Principles

- *The purpose of conservation is to perpetuate cultural significance*
- *The cultural significance will be understood before interventions are considered*
- *Respect context and authenticity*
- *Conservation takes precedence over other demands made of a site*
- *We will ensure the availability of the appropriate knowledge, skills and materials*
- *Interventions should be faithful to the original design intent, materials and construction.*



HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

The Hot-mixed Mortar Collaboration: HES, HE, CADW, OPW, Heritage Council of Ireland and DoC (NI)

Specific Objectives:

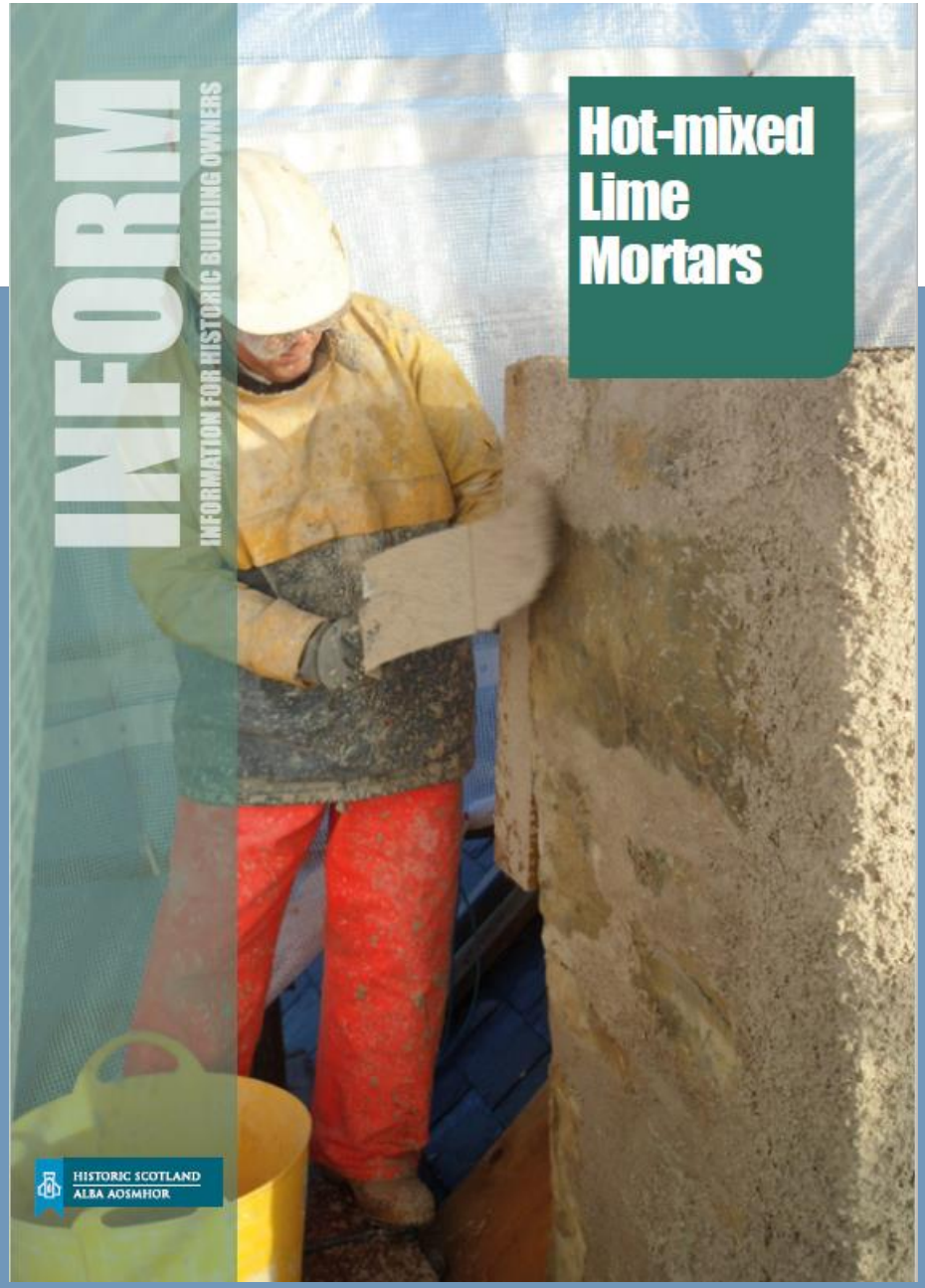
Skills and knowledge: To support specifiers and contractors to develop the skills and understanding of hot-mixed lime mortars and their appropriate use

Build on existing knowledge: Improve understanding of previous use of hot-mixed lime mortars

Support training: Support the delivery of demonstration workshops

Produce guidance: Produce published guidance on the preparation and use of hot-mixed mortars

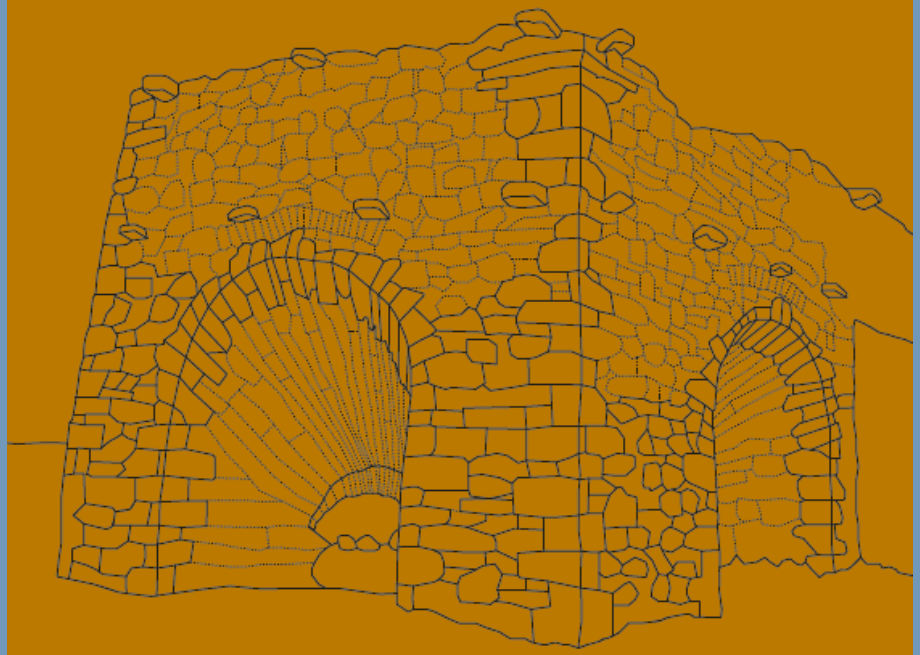
British standard: To develop the production of a British Standard for hot-mixed mortars



6

Short Guide

Lime Mortars in Traditional Buildings



HISTORIC SCOTLAND
ALBA AOSMHOR
National Conservation Centre

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Conclusions

- Hot-mixing mortar is historically authentic
- The archival evidence supports the use of hot-mixed mortars
- Mortar analysis shows most mortars were mixed this way
- Scientific evidence suggests hot-mixing improves performance characteristics
- Surviving examples demonstrate their durability
- Modern examples demonstrate their current relevance

- Better training is required – this is an opportunity!
- Effort needs to be focussed on materials sourcing
- We must take health and safety seriously and promote exemplary standards

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

www.historicenvironment.scot/publications
jessica.snow@hes.scot