



THE STRANGE HISTORY OF THE ENGLISH LIME REVIVAL *

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Abstract

This paper uses data from extensive personal communication and published sources to analyse the following issues:

- Why is current English lime use concentrating on hydraulic lime and rejecting other mortar options?
- Does historic custom and practise offer lessons for the future?

Keywords

Ruins, Wall-capping, Rough Racking, Lime failure, Deviation from specification

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1 Introduction

There are aspects of the current English use of lime that are neither logical nor sensible. There are also substantial differences of opinion over what constitutes good practise.

The lack of an 'agreed knowledge base' is greatly complicated by widespread refusal to acknowledge failure -- and where it is acknowledged, to ascribe blame to contractor error rather than material specification. This paper uses a historical narrative to explain why past practise may be a very poor guide for future success.

2 The Triumph Of Ordinary Portland Cement.

There is universal agreement that hydraulic lime was the 'standard' binder used in high-status masonry structures throughout medieval Europe. However, behind this easy certainty there are unanswered questions :

- Did historic lime-based mortars achieve the ambitions of their creators - were they 'successful'?
- How did medieval craftsmen, specifiers, and clients define 'success'? Over what period was 'success' defined?

Whatever the answers, builders, architects and scientists sought for improved replacements for 'traditional' limes with increasing vigour from the 18th century.

"Since the time of Smeaton very little progress has been made with regard to the use of natural limes and cements, scientists having devoted all their energies to the perfecting of Portland cement...." (Baines F., 1913 p. 76)

The reasons for this quest are not simple. Commercial economics played a role. Lime producers were local and small-scale businesses. There is evidence that their product was inconsistent in quality: "*Set hard and sound in places but still soft after 11 months in other places, due possibly to stale lime...*" (Baines 1914, p.88). Likely, delivery schedules were not 'contractor friendly'. Above all, limes were slow to prepare, often slow to 'cure' and only allowed seasonal working. Given these problems with hydraulic lime, it is not difficult to appreciate how welcome the arrival of OPC must have been.

By the early years of the 20th century, the triumph of OPC was near complete, though house builders were still using lime as a plasticizer in bricklaying mortars (Andrews H., 1950 p.10). Local builders in rural areas, wedded to family tradition, were still using lime for paint and render (Layzell H., pers.com. c.1985).

An excellent overview of how OPC ousted lime is given by Lauren-Brook Sickels, in her doctoral thesis (Sickels L-B, 1987, pp.1-45).

2.1 How Lime Survived: The Ministry Of Works

Without Henry VIII and Oliver Cromwell, England would never have had a lime revival. It is highly improbable that either gentleman ever gave serious thought to building mortars, but they jointly had a far more profound effect : they created ruins. England is infested with darkly brooding ruined castles and the romantic fragments of magnificent abbeys.

Ruins became fashionable and desirable landscape features. Particularly in the 17th and 18th centuries, ruins were incorporated into romantically-engineered landscapes. (Mosser M. and Teysot G., 1991, pp. 203-348). Old Wardour Castle is an excellent example.

Why and how the state took over the care of ruined castles and abbeys is complex and outside the scope of this paper. Such an obligation was acknowledged, and responsibility for ruins was taken over, on a case by case basis, by the Ministry of Public Building and Works

Before the Ministry of Works became the major national guardian of ruins, there had been no consistent approach to their conservation (Thompson, M.W., 1981, p. 36, 70). Frank Baines, as Chief Architect to the Inspectorate of Ancient Monuments, introduced a standard approach to monument conservation. Over the next seventy years, a huge program of conservation was conducted.

Baines was faced with severe presentational problems. For many hundreds of years, the ruins of the Reformation and the Civil War had been....ruins. A strong public perception had developed that 'ruin' was a proper state in which to display historic buildings. But, by definition, a ruined building is not in a stable state, it is in a process of dynamic decay (Smith B.J., and Warke P.A., 1996, pp.3-19). Ongoing decay posed no issues for many private owners, because the ruins were theirs to do with as they pleased. But as the state took ruins on, it also took on a 'duty of care' for these new state assets. This process was strongly self-reinforcing. The more the state spent public money on conservation, the more pressure was generated to prove that the money was spent wisely on durable investments. Baines' response to this pressure was to work with a thoroughness of technique and a suite of materials that would guarantee that his work would 'last forever'.

Unlike Burgess at Castel Coch and Cardiff Castle, Baines chose not to put roofs back on ruins, but to stabilise them broadly in the form in which they were inherited by the Ministry of Works. This is a fascinating approach, probably without historical precedent, and fraught with technical problems.

Baines' most pressing problem was to contrive a way of water-proofing the tops of ruined walls. (Kirkstall Abbey report, 1926, Appendix 2, pp.1-9) (Thompson M. W., 1981, p.24). He did this by taking down the uppermost courses of original masonry and rebuilding them using 'modern' mortar and by realigning the core stones to shed water. The process later became known as 'rough racking', and was usually combined with deep pointing or grouting. It was an elegant solution in some ways. To the untrained eye, 'rough racking' creates the illusion that the wall has not been altered by the conservation process. Some, but not all, find this 'conservation by invisible hand' approach attractive. Others think it is fundamentally dishonest to present new work as old. Baines appears to have been unassailed by doubt, though a vocal minority protested loudly and publicly (Peto H. A., 1921, p.593).

On the scaffold, 'rough racking' and deep pointing posed more than ethical problems. Baines tackled these in detail in the 'Instructions to Foremen':

"Clause 33 Pointing.- Lime mortar only is to be used for pointing, and it is essential that the following instructions should be carefully followed out [sic], in order that the best results may be obtained :-

(a) The joints of the walls should be deeply raked out, to get rid of all loose dirt or old mortar, and to destroy the roots of weeds, grasses, or ivy which may be growing in them.

(b) Old mortar which is apparently sound often has a number of small voids behind the outer surface. When this is the case, these should be thoroughly exposed and the surface mortar cut out.

(c) After cutting out (and before pointing), the joints should be very thoroughly blown out by an air pump, or by using the pressure from the grouting machine if it is on the building. They should then be washed out thoroughly with clean water, by means of a garden syringe, or by a hose-pipe when the latter is possible, or by using the grouting machine under pressure. The bricks or stones should be quite wet when the pointing is

commenced. Care should be taken that no bulk of water remains lying in odd hollows and fractures in the walls.

(d) Where the raking out exceeds 3 inches in depth the joints are, before pointing, to be tamped with cement mortar well hammered home with special tools [sketch of 'tamping iron']. The cement mortar is to kept back a minimum of 2 inches from the face of the wall." (Baines F., 1914, p.109)

The mortar mixes and placing techniques were equally carefully set out and discussed, (Baines F., 1914, pp.107-111) but although the pointing of vertical wall surface is specified in great detail, there is no specific reference to the mortar to be used for capping such walls (Figure 1). Although Baines' instructions appear unequivocal, they have lead to considerable confusion. (See **Complications** below)



Figure 1. An example of the capping of a ruin wall.

2.2 How Lime Survived: The Society For The Protection Of Ancient Buildings (SPAB)

From its inception, the SPAB has been involved in developing practical specifications. As part of this effort, it has always championed the use of lime and, until quite recently, OPC !

In his book , 'The Repair of Ancient Buildings', Powys makes specific recommendations on using non-hydraulic lime and OPC.

- 'Repair by grouting'

..."Repair by grout pumped under pressure from a special grouting machine was first used on ancient buildings by the late Sir Francis Fox...Grouting [with OPC] for the remainder of the wall which is thus brought into equilibrium [by 'repair by building'] is excellent" (Powys AR., 1928, pp.53-55)

‘Mortar’

...”As to mortar for pointing old buildings. The ordinary rules for use on new work apply...Lime mortar is often successfully used and is to be preferred if complete setting can be assured...Hydraulic Lias limes, ground to a fine powder, are commonly used for mortar for pointing old walls....No better mortar for pointing is made than that used by the Ancient Monuments department of His majesty’s Office of Works...”

...”The Society recommends that six or seven parts of coarse sharp clean sand be mixed with one part of lime, ground, slaked or hydrated, beaten up with water at the same time...and knocked up with one part of Ordinary Portland Cement...” (Powys AR., 1928, pp.89-95)

This description is probably the ‘birth’ of the 1:1:6 formula. (See **Complications** below)

From the 1970’s and until recently, SPAB became increasingly hostile toward the use of OPC in general, and steadily more inclined to recommend the use of non-hydraulic lime (See below, Baker’s children). The contradiction inherent in demonising OPC, but simultaneously recommending 1:1:6 and 1:2:9 (OPC : lime : aggregate) mortar mixes, is obvious.

In very recent days, SPAB has continued to popularise all types of lime, though experimental experience has tended to make it much more guarded in its recommendations.

2.3 How Lime Survived: John Ashurst

The world of modern building conservation mortar is rightly dominated by the books of John Ashurst. He is probably the most significant single figure in the movement to re-establish the use of lime for repair of historic buildings outside the Ministry of Works’ own Monuments.

Early contributions were the mortar mix design section of the SPAB Technical Pamphlet on Pointing Stone and Brick (Williams GBA., 1976, p.10), and the revision notes to ‘The Repair of Ancient Buildings’ (Powys AR., 1981, pp.212-3). Much more significant was the publication of the first serious large-scale attempt to review the practical use of lime : *Mortars, Renders and Plasters in Conservation* (Ashurst JA., 1983). This book has been astonishingly influential. It was instrumental in the acceptance of 1:1:6 and 1:2:9 mortars (OPC : lime : aggregate) by a whole generation of specifiers and contractors.

The most recent edition of *Mortars, Plasters and Renders in Conservation* (Ashurst J., 2002) has a comprehensively revised and extended mortar design section, and whilst still including 1:1:6 and 1:2:9 (OPC : lime : aggregate) mortar mixes, it is much more positive in its recommendation of hydraulic limes and pozzolanic mortars.

An interesting feature of all but the most recent of Ashurst’s contributions is his recommendation of *white* portland cement. Despite the statement by Ashurst (Ashurst J. 1988, p.5) that it is weaker than OPC, interesting speculations are possible as to why white cement was beloved of Ministry of Works foremen (See below, 3.1, **Ministry of Works Site Practice**).

3 Complications

3.1 Ministry of Works Site Practice

There is an understandable tendency among later commentators (e.g. Thompson, Ashurst, et al.) to take the Report of the Inspector of Ancient Monuments 1913 at face value. This is not surprising. It has a ring of practical authority about it. Precise arrangements for the provision of toilets and the responsibility for lost tools, not to mention overt threats of 'instant dismissal' for foremen found to have been 'restoring', give the whole a gritty, sharp and well-washed reality. (Baines F., 1914, pp.54-111) But is it fair to use this document as a literal description of 'as-built' site practise?

There is evidence that Baines was a very busy man who did not have time to devote to the conduct of work on individual sites. In a letter to AR Powys (of SPAB), Baines apologises for not having any photographs of the south elevation of Tintern Abbey showing its condition before the Ministry of Works started work. He encloses a postcard! If Baines did not maintain a basic site record for so major a project, how involved was he at a detailed level? (Baines F. 1923, p.1) If he was not a presence on site and in light of the following complications, did Ministry of Works masons actually do what he specified in the Report of the Inspector of Ancient Monuments 1913?

Baines' specification is inherently contradictory. It appears to acknowledge the dangers of using OPC (Baines F., 1914, p.54) and recognise the potential advantages of hydraulic lime mortars (Baines F. 1914, Foremen's' reports p.84 on), but the reality is complex. By specifying his 'deep tamping' technique, Baines was really advocating OPC-based structural conservation 'dressed-up' with hydraulic lime pointing. I don't understand why OPC, two to three inches back from the joint face, is 'good' whilst OPC at the face is unacceptable. I very much doubt that the Ministry of Works masons understood it either. Given the variable performance of the limes in use (Baines F., 1914, Reports by foremen, p.84 on), the acknowledged failures of early work (Baines F., 1914, Reports by foremen, p.84 on), and the independence given to site foremen (Thompson MW, endnote, p.99), it is hard to imagine that some of the white PC in the 'tamping mix' did not find its way into wall capping mixes. (See below : Deviation from specification, for more extensive comment).

Documentary evidence exists to suggest that the use of lime for wall capping was being abandoned within a few years of the Report of the Inspector of Ancient Monuments 1913 : *"Cement mortar with a waterproofing composition is customarily used on flat wall tops and offsets, as it has been found from experience that lime mortar in such places is affected by frost during the winter, and is the subject of scaling and lamination."* (Kirkstall Abbey report, appendix 2, 1926, p.6) This report is not signed, but bears every sign of having been written by a Ministry of Works Inspector of Ancient Monuments. (e.g. It includes mortar analysis sheets prepared by the 'Government Laboratory' for the 'Government Chemist' [Kirkstall Abbey report, main report, 1926, after p.25] and has an assured and intimate knowledge of every aspect of Ministry of Works practise.)

The evidence of the Kirkstall Abbey report is apparently contradicted by Thompson: *"The principle of the treatment is to start from the top of the ruin, which means scaffolding it, and then to work down to the original ground surface. After removal of vegetation, the top of the wall is reset in lime mortar so as to form an impermeable capping that will prevent water percolating down into the thickness of the wall. The object of the work is to renew the adhesion of the mortar."* (Thompson MW., 1981, p.24) However, there are several reasons for disregarding Thompson's description:

- Hydraulic lime would not produce the ‘impermeable capping’ to which he refers. All commentators agree that one of the chief virtues of lime mortar is its permeability.
- One paragraph after his claim that hydraulic lime mortar was used for capping, he qualifies the assertion with “*Nowadays a lime mortar of five parts of sand to one part of lime with some cement is employed,...*” (Thompson MW., 1981, p.24)
- Although Thompson occupied senior positions in the Ministry of Works (and its successors) for many years, he was an archaeologist by training and outlook. The extent of his technical grasp of repair work is unclear, though he clearly did not share Baines’ views on the skill of those undertaking it: “*The craftsmen and labourers required for preservation are the same as those used in the building trade. A works organisation, like a contractor’s business, is no doubt fairly insensitive, but preservation on the scaffold in all weathers is inevitably a fairly crude and insensitive matter.*” (Thompson MW., 1981, p.21). The fact that Thompson mentions Baines only in an endnote (Thompson MW. 1981, p.99) is another indicator that he was not ‘obsessed with technical detail’.

The evidence of the Kirkstall Abbey report is corroborated by the comments of National Trust experts on Ministry of Works mortars used at Corfe Castle: “*Records of the Ministry of Works consolidation activity have not been located, but the strong mortars used prior to the 1980’s are eminently hydraulic and probably cementitious in nature.*” (Stewart J and others, 1994, p28); “*The durable limestone masonry of the Castle does not show manifest damage from the use of strong cementitious mortars of the Ministry of Works, but the inherent properties of cement mortars give good reason to further refine the specification according to a lime based mix.*” (Stewart J and others, 1994, p32.)

Why was white portland cement desirable?: because it could be substituted for lime without changing the visual appearance of a mortar.

3.2 1:2:9 And 1:1:6 Mixes And Hydraulic Lime Supply Problems

Whatever the reality of lime use by the Ministry of Works in the early years of the Ancient Monuments Branch, the early 1970’s were a turning point. The last of the hydraulic limes specified by Baines ceased production (Ashurst J., 1983, p.41). This, theoretically, left the Ancient Monuments Branch with the need to revise their pointing specification to allow use of substitute materials.

How the new specification was researched is outside the scope of this paper, but the SPAB had been specifying 1:1:6 and 1:2:9 (OPC : lime : aggregate) since before Powys. Closer to home, there was long-established official advice. The Ministry of Works itself had published its ‘Advisory Leaflet No.6, Limes for Mortar’(1950). This document recommended 1:1:6 or 1:2:9 (OPC : lime : aggregate) mortar mixes for rubble masonry depending on the season in which work was undertaken. Further published advice from the Building Research Station (BRS Digest 58, 1965, p3-6) and British Standards Institution (Code of Practice CP121.101 : 1951), reinforced the legitimacy of 1:1:6 and 1:2:9 (OPC : lime : aggregate) mortar mixes.

Thus, possibly with some reluctance, the Inspectorate of Ancient Monuments issued new pointing specifications to its work teams. The switch to 1:1:6 and 1:2:9 (OPC : lime : aggregate) mortar mixes does not appear to have produced any visually detectable difference in mortars used on Ministry of Works ruins. Even for the technically aware and determinedly curious visitor, it is quite impossible to discern whether a mortar is pre- or post the end of hydraulic lime specification based on non-laboratory observation. The newer mortars appear to be no-less successful....but appearances can be deceptive.

3.3 Deviation From Specification

Perhaps the *apparent* success of 1:1:6 and 1:2:9 mortars lies with the behaviour of the masons who used them. Plausible evidence suggests that the mortars were made frost-resistant by the substitution of OPC for lime. The actual mixes may often have been 1:3 (OPC : Aggregate).

This deviation from specification was done with the best motives. The Ministry of Works masons were firmly part of the hierarchical tradition of the English building industry. It was simply *not done* to publicly question technical details in a specification. If practical experience and craft training suggested that a specification would not work, deviation would be unobtrusive and private. The obvious question then arises: if the Ministry of Works masons quietly and privately substituted white portland cement for lime, how does this author know about it ? The answer is fourfold:

- I worked as an archaeologist in the 1970s and 1980s on Ministry of Works 'guardianship' sites (e.g. Hailes Abbey in Gloucestershire and South Wingfield in Derbyshire). Because I was interested in what the masons were doing, but was in no way connected with their supervisory structure, they were remarkably open in their discussions of what they did.
- Simple mechanical strength testing of every rough racking mortar sample I have examined (over 40, located throughout England), is consistent with high OPC content. In thirteen years of determined, contract-related experimentation, I have never succeeded in getting lime-based mortar to set as hard as these rough racking samples.
- I have never succeeded in producing a frost-proof lime-based wall capping despite numerous and determined attempts.
- Observation of recent genuinely lime-based mortar repairs to ruins has shown a high short-term failure rate.

The conversations and observations listed above do not constitute formal proof of anything. They do however, *strongly suggest* that systematic and widespread deviation from specification did take place. The breadth of deviation is impossible to know without scientific analysis of mortars from many sites. Even where accessible published information can be correlated with basic site observation, definite conclusions cannot be drawn. For example, Ashurst (Ashurst J, 1983 p.22) states that the mortar used for pointing at Old Wardour Castle was 1 cement : 12 lime : 32 sand (actually published as $\frac{1}{8}$: $1\frac{1}{2}$: 4). The mortar used for all the (visitor-accessible) pointing appears to be around 1 cement : 3 sand. Perhaps the recipe that was published failed and was later repaired. Is the written record to be believed over the evidence of the fingernail ? Perhaps these comments by Thompson, even though written in a different context, are useful: "*There is perhaps a clue here to the marked reluctance of some academic historians to take cognisance of [physical] ruins; it is as if the freer flow of the imagination allowed by written sources is obstructed or constrained by the tangible remains of the period.*" (Thompson MW. 1981, p.86.)

'Well-intentioned-deviation-from-specification' is, in my direct experience, still commonplace in modern conservation. The problem is that a mythology of lime has been created, and given unprecedented publicity by Ashurst in *Mortars, Renders and Plasters in Conservation*, (Ashurst J. 1983 pp. 40, 42, 49, 50)

3.4 Privatisation

The large scale conservation adoption of 1:1:6 and 1:2:9 mortar mixes coincided with Robert Baker's 'Lime Method' at Wells Cathedral and the introduction of 'privatisation' to the Ministry of Works. The government of Margaret Thatcher deemed it inappropriate for the state to directly employ maintenance workers on the masonry of ruins. They were sacked. Their expertise went with them and also the oral tradition of how their fathers and grandfathers had adapted unworkable mortar specifications.

The ruins still required maintenance. Enter a new generation of contractors. These contractors were (and are) handed the specifications that were ostensibly used by the directly-employed masons, and told to replicate that success. Despite the lack of trust that is commonplace in the English building industry, most contractors are mostly honest and diligent. They have followed the 'post-Baines' specifications, and their lime-rich mortars have duly failed.

The English building conservation world has watched this tableau with considerable interest. Lime failures have not been confined to ex-Ministry of Works ruins. I have seen a significant proportion of my own work fail. In moments of candour, all contractors would admit to similar problems. The common factor in these failures appears to be the adoption of 1:1:6 and 1:2:9 mortar specifications on work with a high risk of frost damage.

4 Robert Baker and 'The Lime method'

Of all the bizarre episodes in the world of English lime conservation, the Robert Baker Lime Method stands out (Ashurst, J. 1984, 233-252, and Price J. 1984 p.301-312). Baker was a ceramicist with a particular interest in medieval floor tiles. In the mid-1970's, he undertook work to clean and repair part of the exterior of Crowland Abbey. This work appears to have set him on a mission to re-invent the conservation of exterior limestones.

The major part of this quest was played out at Wells Cathedral. The process he developed involved using lime for cleaning, repairing and consolidating most of the major limestone sculptures on the West Front.

Each of Baker's techniques was not new in itself, but their combination into a 'method' was new. Baker was also an extremely astute showman and publicist. Some parts of the 'method', for example the claim that 'lime-water' can be used to deposit fresh calcium carbonate into the matrix of severely decayed stone, have been fairly convincingly discredited (Price C., Ross K., White G., 1988, p.178-186) (Quayle N., 1996, p.22-27). Whether the lime method 'worked' is hard to say.

I worked on the West Front for eighteen months, and was involved in a variety of technical absurdities (e.g. the addition of whey to sheltercoats as a source of casein, or the production of mortar mixes containing extraordinary levels of fines). With maximum hindsight, my feeling is that the technical failings of the lime method were compensated by the astonishing levels of 'tender loving care' devoted to the work.

What is certain is that Baker succeeded in massively promoting two key ideas:

- Non-hydraulic lime, used as putty, can do anything
- OPC is the work of the Devil and should not be used under any circumstances

Just as the Ministry of Works activity declined under privatisation, there sprang up a new breed of lime users : 'Bakers' Children.'

4.1 Baker's Children: Lime Putty for All

The growth of Baker-inspired lime use cannot be accurately quantified, but enduring media interest was aroused (Powers A., 1993, p.46). Perhaps the increased sales reported by a well-established lime putty supplier in Bristol provides a hint: in 1989, this firm boasted of a 100% increase in sales in each of the previous three years (Chard, D., personal communication). However, this supplier was not

the only firm to benefit. At least ten new, independent putty suppliers were established from the middle of the 1980's onwards. Most are still in business, though their sales volumes are unknown. Whilst some of this lime putty was undoubtedly used by 'ordinary builders', almost none went into 'new-build'. The vast bulk went to conservation specialists, many of whom, like myself, trained on the West Front of Wells Cathedral. Quite literally, 'Bakers' Children' descended from the scaffold at Wells and evangelised lime putty. (Burman P., 1996 p. 28) (Young R., 1996, p. 57).

So why has non-hydraulic lime putty failed to become the universal base for English lime mortars? The answer is that some of the evangelistic enthusiasm was misplaced and another set of complications soon became apparent.

5 Further complications

5.1 The story so far

The conservation efforts of the Ministry of Works and the SPAB kept specialists' interest in lime alive, but it was a narrowly-defined interest, obsessed with hardness of set, lack of shrinkage, and rapidity of set. How widely the Ministry of Works used the lime mixes that were specified by Baines, or his successors, is open to question.

The wider revival of lime use can be attributed to the publications of John Ashurst, and the work of 'Bakers' Children'. At the same time that they left Wells and started to experiment with lime putty-based mortars, the Ministry of Works direct labour force was disbanded. 'Bakers' Children's' attempts to apply lime putty-based solutions to Ministry of Works ruins lead to significant levels of failure.

5.2 Success or Failure?

The quantity of lime failure that has occurred since the Baines' report as Inspector of Ancient Monuments (1913) cannot be accurately assessed. This is not surprising. We do not really have any workable definitions of 'success' and 'failure'. A lime-capped wall where the mortar is frost-damaged is seen as a simple failure, rather than the first stages in the establishment of a natural soft wall cap. The problem is complicated by widespread lack of candour. Commercial contractors cannot afford to be seen as 'honest failures'.

6 Reaction

Many workers in the field have come to examine their working practices and question their choice of materials. Thus, the practical consequences of the strange history of English lime, so far, have been:

- The adoption of hydraulic limes because they are perceived to be 'safer' than non-hydraulic limes. The risks of over-hard final set, increased brittleness, reduced autogenous healing, and inferior permeability are overlooked out of fear of short-term mechanical failure. (Source: an informal telephone survey of 15 lime contractors and sellers, 2004)
- The sensible use of non-hydraulic lime with added pozzolanic material has been significantly reduced, again because non-hydraulic limes are seen to be excessively failure-prone. This is serious because non-hydraulic lime plus pozzolan mortars are a source of highly frost-resistant and breathable mixes. (Teutonico JM., 1994, pp.32-49)
- The use of putty lime, by definition non-hydraulic, has been reduced even where it has undoubted advantages (e.g. limewashes). Again, the fear of failure is the illogical driving force. (Source : Informal telephone survey of 10 architects and 4 conservation contractors, 2005).
- The development of increasing resistance to lime : cement mortars, because of faulty extrapolation of evidence from known failures. If lime and cement are used in the wrong relative

proportions, there is an increased frost-damage risk (Holmstrom I., 1993), (Forster AM., 2004, p.8). But it is a very specific risk to a narrow range of applications such as 'rough racking.' It is illogical to generalise the risk to other applications. This is of particular concern outside the narrow boundaries of lime use in conservation. The exotic mortars that are useful to meet the specialist demands of conservation are largely irrelevant to new-build, and international experience suggests that they do have a wide role.

All the above responses should be deeply-worrying to anyone concerned with the production of suitable and cheap mortar.

7 One Lime To Find Them All, And In The Darkness, Bind Them

Does the history of lime in English conservation hold any lessons for the wider world? Perhaps it demonstrates misunderstandings about building limes and their applications.

The roles that lime is expected to fulfil are hugely varied. Lime : cement mortars are not suitable for the highly specific application of capping ruined walls, or for any application where there is a significant risk of frost damage (Holmstrom I., 1993.,pp. 32-41), (Teutonico JM., pp.32-49), (Stewart et al., p. 31, 32), but that does not mean that they have no role. There is no evidence that any one type of lime is the best choice for all uses. Both conservation and new-build construction need an extensive palette of materials to cope with varied demands.

In recent years, huge strides have been made towards a better understanding of lime mortars. The work of Holmstrom, English Heritage (Smeaton Project), the National Trust (trials at Corfe and Hadrian's wall), SPAB, and members of the Building Limes Forum has done much to put mortar specification on a scientific footing. But all is not yet well. Misunderstanding the lessons of past practise has led specifiers and contractors to the brink of abandoning both non-hydraulic lime and lime-cement mixtures. The only people to benefit from this illogical behaviour are the manufacturers of OPC and hydraulic limes. Buildings are likely to be the ultimate losers.

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