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Conservation *bulletin*

Building Materials

Contents

The character of England's historic buildings owes everything to the traditional materials of which they were made. But when those materials decay, how should we repair and replace them?

Good conservation depends not only on a deep understanding of the properties of historic materials but also the skills to use them. Following a 12-month Traditional Building Skills Bursary Scheme placement Simon Doyle is now running his own specialist heritage blacksmithing company.

ENGLISH HERITAGE

Editorial: *Why Materials Matter*

Repairing historic buildings with authentic materials sustains their character – and in turn supports traditional industries and vital craft skills.

A few months ago I attended a meeting with an MP who wanted English Heritage to encourage local authorities to allow local stone slates to be replaced by concrete facsimiles on listed buildings. The MP was acting in support of a constituent who was faced with expensive repairs to a number of listed buildings and on behalf of a local firm that was making the concrete slates. Besides the cost savings, they argued that it would generate local employment.

The starting point of our discussion was the fundamental significance of authentic materials to a listed building. Few people would dispute the aesthetic value of natural Cotswold slates, which blend seamlessly with their supporting stone walls. Their visual appeal comes not solely from their colour and texture, but also their variable sizes and thicknesses, further enhanced by the colourful lichens that are attracted by the their rich collection of minerals.

Centuries of practice lie behind the ability to turn unpromising, randomly shaped stone into a weatherproof covering. By contrast, the mechanically uniform concrete slate is far less attractive to lichen and the subtle patination of age. And if we fail to support the use of natural slate, we jeopardise the employment prospects for the quarryman and roofer whose skills are crucial to its sustainable use, as well as the wider rural economy.

Original material is unique; once it is removed much of the character and significance of a building goes with it. Nonetheless, even the most durable components will eventually need to be repaired and this is best done using authentic materials and techniques. When a Cotswold house is re-roofed, most of the existing slates will be recycled but there will always be some that have to be replaced. In these cases we positively advocate the use of new slates rather than reclaimed ones from elsewhere, partly because we want traditional sources of stone to remain economically secure (see Lott pp 5–7) and discourage the stripping of old roofs to provide supplies, but equally to make sure that vital craft skills are kept alive through viable local employment (Houghton and Willet pp 40–1).

This edition of *Conservation Bulletin* demonstrates the importance of traditional building materials and the lengths to which people will go to make sure they are properly conserved. Selecting the right material for repair is essential, otherwise even worse problems follow (see Lott pp 5–7; Ridout pp 7–8; Henry pp 16–18). Understanding how a structure is performing is also essential and can require lengthy and sophisticated monitoring and interpretation (Curteis and Pender, pp 18–21). On occasions it will become clear that it was actually the original structure that was at fault (Inskip pp 33–4), meaning that repair has to include alterations to the initial design and selection of materials. Entirely new challenges like climate change need to be faced. The need for buildings to be more energy-efficient is resulting in pressures to replace traditional materials with more sophisticated substitutes. However, recent research has begun to indicate that historic buildings can actually perform as well or better than their modern counterparts (Rye pp 22–3; Rhee-Duverne pp 23–4).

We have a wider perspective today on the values that makes up the significance of historic buildings. But this has not diminished the importance of historic fabric – our only tangible links to the past and the reason we are able to enjoy such a rich diversity of buildings. Our knowledge is increasing all the time but many challenges remain and new ones continue to emerge, as this edition makes clear.

Chris Wood
Head of Building Conservation & Research, English Heritage

Conservation Bulletin is published twice a year by English Heritage and circulated free of charge to more than 5,000 conservation specialists, opinion-formers and decision-makers. Its purpose is to communicate new ideas and advice to everyone concerned with the understanding, management and public enjoyment of England's rich and diverse historic environment.

When you have finished with this copy of *Conservation Bulletin*, do please pass it on. And if you would like to be added to our mailing list, or to change your current subscription details, just contact us on 020 7973 3253 or at mailinglist@english-heritage.org.uk

Principles of Repair

Even the best-loved buildings eventually need to be repaired. So how do we retain their original character while keeping them fit for purpose?

Building conservation can be a relatively straightforward process. As Douglas Kent (pp 10–11) demonstrates, regular systematic maintenance minimises the loss of fabric and avoids the need for expensive and disruptive remedial work. Unfortunately, maintenance is too often ignored, meaning that invasive repairs are the unwelcome and costly result.

But this is only part of the story. Old buildings inevitably decay over time and repairs or replacement materials are needed. English architecture is blessed with a huge variety of different stones but sourcing the right replacements requires considerable expertise and investigation (Lott pp 5–7). A failure to use appropriate materials and techniques can have dire consequences, not only for the production of stone but for specialised products like terracotta (Thorne pp 9–10). Similarly with timber repair: sourcing exactly matching wood is sometimes impossible, so it is essential to understand the limitations of the available alternatives (Ridout pp 7–8). Knowing how materials perform in the context of a particular building is another essential precursor to specifying appropriate repairs (Wood pp 3–5).

Practical Building Conservation

Chris Wood

Head of Building Conservation & Research, English Heritage

Earlier this year, the first five volumes of the new English Heritage *Practical Building Conservation* handbooks were published by Ashgate Publishing, with the next five scheduled for early next year. This will mark the culmination of several years' work by the Building Conservation and Research team (BCRT), with significant contributions from many of their consultants and colleagues at English Heritage and others within the sector. Although these hardback books may well be the last of their kind, it is hoped that the volumes will provide an important repository of information for those who look after historic buildings and structures.

The need for a new series

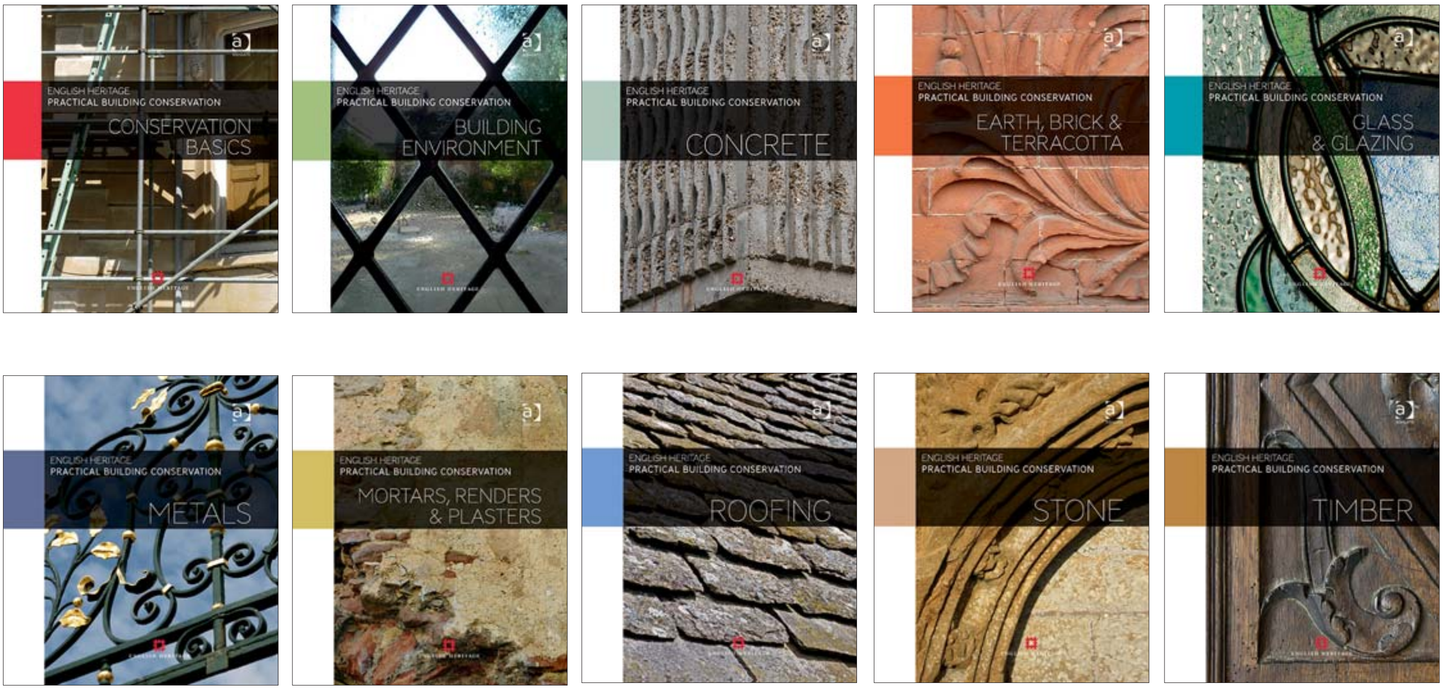
The decision to produce the new series was not taken lightly. The original set of five volumes by John and Nicola Ashurst, published in 1988, were much admired. The clarity and succinctness of the series made them standard references on building conservation, both in the UK and abroad. But their coverage was relatively limited, concentrating on the casework and advisory requests that the Research and Technical Advisory Service team (RTAS, predecessors to BCRT) dealt with. They gave little guidance on diagnosing faults or assessing the extent of interventions or alternative repair options, but simply described how a problem might be tackled using previous examples from ancient monuments casework.

Perhaps the main concern with the original series was that some of the advice was out of date, or proved wrong by subsequent research work carried out by BCRT and others in the 1990s. There was also a clear need to produce more comprehensive guidance on repairing and maintaining all the main building materials and systems that are essential for good conservation.

The proposal to replace the original series was given a strong fillip by the active encouragement of John Ashurst himself. He was very much involved with some of the initial drafts, especially those embracing his pet subjects of stone and mortars. Indeed, some of his last writings before his untimely death survive in these new volumes. The series is dedicated to John, as a mark of respect for his support and outstanding contribution to the conservation of building materials over many decades.

The new series

The new series consists of eight volumes covering specific materials, and two further volumes, *Conservation Basics* and *Building Environment,* which deal with overarching issues. The series is aimed at those who look after historic buildings, or who work on them. Specifically, the target audience is: architects, surveyors, engineers, conservators, conservation officers, curators, students and researchers. Each of the new materials volumes (eg *Stone*, *Timber*, *Concrete* etc) follows a common format. An introductory section on the history and production of the material in question is followed by a detailed look at the causes and mechanisms of decay. This leads on to sections about recognising faults, assessing damage, and evaluating options for repair. Finally, repair materials and techniques themselves are described in detail. Many of the volumes also include additional 'special topics'. For example, *Stone* covers the



The ten-volume *Practical Building Conservation* series is available to purchase from the English Heritage online shop (www.english-heritageshop.org.uk) and from Ashgate Publishing (www.Ashgate.com)

The first five volumes were published in March 2012 and the remaining volumes are due to be published in early 2013.

conservation of ruins and the mortars used for stone conservation while *Glass and Glazing* deals with ornamental architectural glass, glass blocks and other 20th-century glass components.

The books do not provide specifications for carrying out repairs. Instead, they offer the reader illustrated guidance about the respective benefits and limitations of available methods and the factors that influence the choice between repair or treatment options in any particular case. The importance of selecting experienced conservators, tradesmen and craftsmen is also highlighted. The value of routine and regular maintenance to maximise the life of fabric, and minimise the need for costly and lengthy interventions is emphasised throughout the series.

The new series also reflects the changes in policy and practice that have taken place since the original editions were published, in particular the application of English Heritage's *Conservation Principles* (2008) to the business of conserving assets, ancient and modern.

In common with the first series, the overriding aim has been to provide advice and guidance that is essentially practical. Each volume is copiously illustrated with drawings and photographs and has a comprehensive index designed to allow readers to find information easily. All books attempt to avoid jargon but assume most readers will be familiar with technical building terms. Glossaries are included, along with references for further reading and additional sources of information.

New repair techniques and materials are included although warnings are given where these have yet to display good longevity. For example, 'nanolime' mixes appear to offer exciting possibilities for consolidating stone, and although BCRT has commissioned research their long-term performance has still to be assessed. The books also address forthcoming climate change challenges such as the increasing need to make buildings more energy efficient, and the emergence of new insect species that can harm timbers in building (the *Timber* volume includes hitherto unpublished information on this potential risk).

Although the books are lengthy (*Mortars, Renders and Plasters* runs to over 650 pages) they can never hope to be totally comprehensive. They concentrate on topics that are significant in conservation terms, and reflect the requests for information and help that BCRT has received over the years.

The next stage

Once all the books are published it is planned to supplement them, in due course, with detailed online advice and guidance, such as demonstrations of repair techniques. As further information on materials and techniques becomes available through research projects, it too will be made available in digital form. However, there are no plans to produce on-line versions of the books themselves. When the work first started this option did not exist, and the practical and copyright issues would now make this a mammoth task. All of the layout, design, copyright clearance, drawing of diagrams and sourcing of photographs has been carried out in-house and has proved to be at least as onerous as actually writing the books. Future reprints will, however, include minor updates and revisions.

The new series of Practical Building Conservation has been long in the making and is unprecedented in scope. It brings together the accumulated knowledge, expertise and experience (totalling several hundred years!) of all the people who have contributed to its production. If they become the dog-eared friends of many building professionals for years to come, then that will be our reward.

For further information on the series go to **www.english-heritage.org.uk/pbc**

Stone matching – is there a right way and a wrong way?

Dr Graham Lott

English Stone Forum

England is fortunate to have a very diverse heritage of stone buildings. However, it is that very diversity that has made this inheritance increasingly vulnerable to a marked decline in the range of natural stones that are being actively quarried.

Stone in general is a very durable building material but there is a tendency to forget that its exposure to the elements over many centuries will find weaknesses in even the best stone. In recent decades building stone research has tended to focus on understanding the causes and consequences of this decay. While clearly of considerable interest, this research does not answer the more practical needs of those individuals and organisations directly concerned with the preservation of their local churches, houses or other historic structures. For them the more pressing issue is to identify and locate suitable stone to repair an already severely decayed fabric.

Cavernous decay of the 'white' Triassic sandstone used in the Priory church at Breedon on the Hill in Leicestershire.
© Graham Lott

We therefore need to continue our efforts to ensure that enough varieties of stone remain in the market place to meet current and future demand for conservation and sympathetic new-build projects. Advice on how to approach stone matching is provided in English Heritage's Technical Advice Note *Identifying and Sourcing Stone for Historic Building Repair* (**http://www.english-heritage.org.uk/publications**) and various conference proceedings in the field of stone conservation (see Henry, pp 43–4).

The process of stone matching addresses three fundamental questions; what type of stone is it; where did it come from, and where can I get a matching stone.

What type of stone is it?

The accurate petrographic description of a building stone is a prerequisite for its identification. Ideally, the sample supplied for analysis should be representative of the building fabric and not, as is often the case, be taken from an area of failed stone. The petrography of a building stone – its mineralogy, natural cements and porosity – can be determined by thin-section analysis. To ensure quality and consistency in their production, thin sections should be prepared by an accredited laboratory, following internationally agreed standards. In essence, a thin section is prepared by grinding a rock slice to a thickness of 30 microns (thin enough to transmit light) and then mounting it between two glass plates. Modern thin-section preparation also involves the introduction of dyes and stains, which help to distinguish the different mineral and cement phases present, and allows a preliminary evaluation of the pore system of the stone. An experienced petrographer will be able to identify the stone source to at least a generic level (eg Carboniferous, Jurassic or Cretaceous in age). Petrographic analysis is also used to identify potential matching stones from current production, thus minimising the possibility of mineralogical and porosity/permeability mis-matches that could become unsightly and cause further decay in the long term.

The original Permian (Cadeby Formation) magnesian or dolomitic limestone tower buttresses of St Mary the Virgin at Swine in East Yorkshire have been replaced with a Carboniferous sandstone.
© Graham Lott

Where did it come from?

There are few parts of England where natural stones have not been used in the local historic architecture. Until the 19th century many stones were collected or quarried within a comparatively short distance of the building in which they were used. Most such local material was used as rubblestone, while more durable stones dressed for use in quoins or for ashlar, were often imported from further afield. Easily split (fissile) stones suitable for paving or roofing are less common in the geological succession and in general would have to have been transported at much greater expense.

Developments of our transportation systems since the 19th century, however, have considerably disrupted this simple pattern of use. Consequently, when examining stone buildings of the 19th and 20th centuries the best advice is to always expect the unexpected in terms of the stone used. Among the stone structures of this period, Britain's building stones are spread indiscriminately across the country. You are now almost as likely to find a Carboniferous sandstone from Yorkshire in use in Edinburgh or London as in Yorkshire itself!

The Strategic Stone Study (SSS) funded by English Heritage, currently covering 32 English counties, has clearly demonstrated that the diversity of local stones used for building has been understated (see McAlester pp 24–5 and **www.english-heritage.org.uk/strategic-stone-study**).

Where can I get a matching stone?

The simplest way to match a stone in a building to a precise quarry is to use original documentary evidence. Experience, however, has shown that contemporary statements regarding stone sources may occasionally lose something in translation and therefore still need to be checked. Experience also tells us that many historic buildings have a long history of *ad hoc* stone replacement, extensions or alterations, much of it undocumented. In this situation it is important to clarify whether the stone being matched belongs to the original construction or to a later phase of repair work.

Commonly, however, documentary evidence is not available and sourcing a matching stone becomes a matter of systematic scientific research by a specialist. Information on the building stones in current production is generally available in company brochures, stone directories or in geological literature. However, a large proportion of local building-stone sources, including many of those revealed by the SSS, have not as yet received such systematic treatment because the numbers of stones involved is simply too great. Some information on their geology, mineralogical composition and character is likely to be available, but only if one knows where to look. In many cases it is buried deep in the local geological literature or in the archives of the many individuals, organisations and companies who in the past have been extensively involved with conservation of England's stone buildings.

Future research – where do we go from here?

Research into building stones and their use has been taking place in the UK for more than 150 years. Like most research carried out over such a long period of time there have been many changes in methodologies and focus. In the past, stone surveys will have been commissioned on many of our more important historic buildings, involving different companies and individual specialists. A good survey should have examined, documented and attempted to match to original sources before addressing the problem of finding a suitable matching stone in a contracting market.

Access to such historic information could improve current stone-matching efforts and provide evidence of the long-term suitability of some selected replacement stones used in earlier stone assessments. Unfortunately, often for reasons of commercial confidentiality, much of this basic information is difficult to access. It is held by a wide range of organisations and will often have been 'lost in the system' as organisational changes have

St Bees Priory, Cumbria, the Norman west door: Triassic St Bees Sandstone door mouldings, repaired using the local red St Bees Sandstone from recent production. The original stonework includes characteristically variegated St Bees sandstone, which should be a consideration in any further stone repair.
© Graham Lott

taken place or as research and funding priorities have changed. Many other commercial companies and individuals have gone altogether, and their archives with them.

As a result, it is very likely that we are unknowingly revisiting buildings and historic structures whose stones have already been examined in the not too distant past. There is a clear need, therefore, to continue to develop the SSS as a freely accessible national database of building stone information. Such a database should also become a repository for the results of research work carried out by now-defunct organisations or individuals.

As is already the case with the SSS, this expanded database could be made accessible via an internet portal and contain relevant data on all our building stones resources including their typical mineralogical composition, decay patterns, records of known use, current availability and copies of previous stone-matching reports.

Current financial constraints, together with the fact that the use of building stone is no longer limited by national boundaries, mean that heritage organisations need to work more closely together, perhaps co-funding a documentation project of this kind. This would ensure that the results of all past, present or future building-stone research would be properly archived and disseminated, for the long-term benefit of this country's stone-built heritage and the UK stone industry on which it depends for its survival. ■

Selecting softwood for durable repairs

Dr Brian Ridout
Building Research & Conservation, English Heritage

It is generally accepted that modern soft-wood timbers do not have the same durability as those found in 18th- or 19th-century buildings, even though they may have been taken from the same tree species. This has traditionally been attributed to the narrower growth rings of the older wood, which grew slowly in a cold northern climate. Many building professionals will look at the wider growth rings of modern softwoods grown in a warmer climate – perhaps Scots pine from the UK – and declare the timber to be rubbish. However, this misses a much more important cause of reduced durability and thus the ability to choose the best timbers for repairs.

Softwoods were not much used in the UK for structural purposes until the second half of the 18th century. By that time oak, which had been the timber of choice for centuries, had become very expensive. Instead, it became commercially viable to exploit the vast pine forests of northern Europe, the logs from which could be floated down rivers to the ports of the Baltic. Underpinned by an excellent export and import infrastructure, the trade was huge, and with the exception of a few years when Napoleon tried to blockade the ports, it flourished until the end of the 19th century. This is the timber that is found in most of our historic buildings that date from about 1750 to 1900.

The trees were 200 to 300 years old when felled and were never going to be a sustainable resource. Reduction in availability was compounded by the requirements of the First World War, so that by 1918 good-quality timber was in very short supply and the only options were to exploit secondary growth or to cultivate the trees in plantations. A Scots pine tree could now be grown in the UK to a marketable size in 40 to 50 years, but did it have the same properties as its far older European counterpart?

The answer was provided by research into the properties of home-grown timber carried out by the now-defunct Forest Products Research Laboratory. An important conclusion, as far as pine was concerned, was that the heartwood of trees grown in Hampshire was as durable as those from northern Europe. English Heritage has continued this research and found that the phenolic chemicals thought to confer natural durability are mostly in the pale early wood of an annual ring, and it is this early wood that makes growth rings wide when the tree grows in a favourable environment.

We now know that the poor durability of modern softwood is not caused by wide growth rings but by the outer band of sapwood that conducts sap from the roots of the tree to its crown. Unlike the heartwood into which it gradually converts over time, young sapwood lacks the chemicals that confer natural durability. It is the central core of heartwood that supports the tree, and it is its natural durability that we exploit for construction timbers. A growing tree generally maintains about 20 to 30 years of sapwood, which is a relatively small proportion of a 200-year old tree but a much larger percentage of one felled after only 45 years of growth.

All of the pathogens that attack softwood, from furniture beetle to dry rot, will rapidly destroy damp sapwood. When repairing historic buildings it is therefore important to select timbers that contain the minimum amount of sapwood.

The absence of inbuilt preservatives also makes sapwood more permeable than heartwood – a property that allows pre-treatment with artificial biocides in place of natural phenolic chemicals.

A pine log in the forest with fungus in the outer sapwood but not in the more durable red heartwood.
© Brian Ridout

While such processes successfully overcome the durability problem they leave chemically contaminated waste when a structure is demolished. An interesting potential solution lies in the recent development of acetylated soft wood. In this process the cellulose is modified by binding it with the major component of vinegar. This not only greatly enhances the durability of the sapwood but also makes the timber more dimensionally stable.

Slow-growing and thus durable Baltic pine was used for most of our historic buildings between 1750 and the end of the 19th century.
© Brian Ridout

Maintaining the terracotta tradition

Robert Thorne
Consultant, Alan Baxter and Associates

The conservation of terracotta has come a long way in the last 30 years but is still evolving. Most buildings in England that incorporate the material date from the period 1860 to 1939. In contrast to masonry or timber buildings, where conservationists can call on many generations of experience, terracotta buildings have only fairly recently entered the conservation agenda because only now have they reached their first or second major overhaul.

A lingering contempt for Victorian and Edwardian buildings in the 1960s and 1970s meant that little detailed thought was given to how terracotta should be cared for. Over-zealous cleaning, including the use of hydrofluoric acid, tore away the resilient fireskin that gives terracotta its attractive sheen. Crude cement repairs, ill-matched to the original material, ruined the integrity of the blocks, as did the drilling of holes for fixings and signs. More sympathetic attitudes only began to take hold in the 1980s. A landmark public inquiry decision in 1984, in favour of the reinstatement of the authentic material rather than the substitution of fibreglass, was a crucial turning-point.

Terracotta came to the fore in the late 19th century because it combined artistic pretensions with factory production, but above all because of its durability and strength in a polluted industrial world. It appeared to be, as one advocate put it, 'practically time-proof and indestructible'. Such claims, in many respects quite justified, led people to overlook its vulnerabilities. Though the blocks themselves, if properly specified and manufactured, could perform superbly, much depended on how they were constructed on site and the care given to waterproofing.

Replacement terracotta cornice block fabricated at Shaws of Darwen.
© Alan Baxter & Associates

Where deterioration and faults have occurred they can usually be attributed, apart from ill-treatment, to the effects of water ingress. Cracked or missing mortar, or inadequate flashings and copings, allow the freeze–thaw cycle to damage the blocks and water to reach the material used to fill them. Water causes most damage if it reaches the iron dowels and anchors that were often used to secure the blocks: their rusting results in the cracking or spalling of the blocks, or at worst the dislodging of whole pieces. When terracotta (or its glazed version, faience) has been used as a cladding for steel-framed buildings these problems can reach a yet more serious dimension, requiring the assessment of corrosion throughout the structure.

As with stone, the techniques for mortar repairs have developed through the better understanding of the mortars themselves: impervious cement mortars are not appropriate. Fractures can be repaired using epoxy resin, coloured with fine stone dust or crushed brick to match the original. More serious fractures can be secured with stainless-steel dowels.

But because terracotta is a factory-made not a natural material, its conservation does present some unique issues. These come to the fore when the scale of damage or deterioration demands the replacement of whole blocks. At the procedural level, the specification and manufacture of new blocks is a demanding process with significant implications for the programming and cost of a conservation project. And at the philosophical level questions are inevitably raised about the authenticity of the end result.

Because building conservation is now an important part of their work, the firms that can supply replacement terracotta and faience are alive to these problems. They have excellent credentials for authenticity because they adhere to the essentials of the historic manufacturing process, but inevitably with some variations. The clays they use are different because most historic sources of supply are now unavailable, but original effects can be reproduced with colourants. At the stage where the blocks are moulded there is a tendency to favour slip-casting rather than hand-pressing the clay into the moulds. The result is more consistent and smoother blocks: only an expert will notice the difference. And in

Lambeth North Underground Station (1906), repaired using slip-cast faience. © Alan Baxter & Associates

firing the blocks, contemporary kilns produce a more homogeneous result than traditional kilns. If this is at odds with the intended effect, colour can be added to reproduce the variations in the originals.

As long as the surviving manufacturers have enough work in hand the outlook for terracotta conservation is good. But there is much still to be done in spreading knowledge about how to care for the material, particularly among architects and practitioners who may not yet appreciate its special qualities. The forthcoming *Earth, Brick and Terracotta* volume of the the English Heritage *Practical Building Conservation* series looks in detail at this issue.

Maintenance matters

Douglas Kent

Technical and Research Director, Society for the Protection of Ancient Buildings

On founding the Society for the Protection of Ancient Buildings (SPAB) in 1877, William Morris urged the guardians of old buildings to 'stave off decay by daily care'. His words highlighted the importance of good maintenance – that is, routine work to keep the components of a building functioning in an acceptable condition for as long as practicable.

Morris's message remains valid today. Although it is now reiterated in national and international guidelines, the SPAB currently runs National Maintenance Week every autumn to continue championing the value of good maintenance, especially of the preventative kind.

Benefits

When dealing with an older building, it is important to safeguard the fabric (physical authenticity) and not just the function. By restraining, or even obviating, the need for repairs later, preventative maintenance minimises the loss of fabric and represents the most practical form of building conservation. Regularly clearing out gutters to prevent blockages, for example, can stop serious deterioration of a wall or window below.

Neglected maintenance is costly in financial, as well as fabric, terms. Failing to forestall deterioration now can lead to greater long-term expense and reduce the market value of a property. According to recent research by English Heritage and the London School of Economics, the price of a poorly maintained property in a conservation area is depressed on average by nearly 4%.

Good upkeep minimises disruption to occupants due to the failure of components and more extensive remedial work. It enhances the appearance of buildings and contributes to a sense of pride within local communities. By avoiding the unnecessary loss of fabric through neglect, it conserves natural resources – including building materials that may no longer be readily available – and sustains old buildings for future generations to use and enjoy.

Regular action

Preventative maintenance entails regularly inspecting the different parts of a building at various frequencies, depending on their significance and

Every autumn for the past 10 years, the SPAB has run National Maintenance Week endorsed by celebrities such as Laurence Llewelyn-Bowen.
© SPAB

vulnerability. A ladder and other basic equipment is usually all that is required. No two properties will deteriorate in an identical way but knowledge of the principal decay mechanisms – not least dampness, the biggest enemy of buildings – assists with the anticipation and remedy of faults.

With more extensive property portfolios, 10-year costed and prioritised maintenance programmes can be generated from inspection reports to assist with policy decisions and budgeting. Some defects are hard to detect in their early stages so there needs to be an allowance for rectifying urgent, unforeseen problems. Arrangements can be made with contractors to undertake certain tasks on a regular basis, such as clearing out gutters and drains or servicing boilers. Work carried out should be recorded in a log book.

Problems

Owners frequently fail to properly maintain their property, despite it being for most their largest financial investment. Attention is focused instead on cosmetic items. All too often, there is a tendency to wait for problems to develop rather than take action to prevent them occurring in the first place.

Some notable exceptions exist. The Church of England's system of five-yearly condition surveys is credited with keeping our parish churches in a significantly better repair than they would otherwise be, given the general scarcity of funds for fabric-related work. And in Peterborough, an enlightened initiative supported by the Heritage Lottery Fund, English Heritage and others recently set out to raise awareness of the city centre's heritage and promote its good management.

Maintenance must not remain the 'Cinderella' of the building sector. Listing imposes a responsibility on owners to obtain approval for alterations but no obligation to keep buildings in good repair. However, a 'duty of care' may be introduced in Wales in the near future, a legal liability that deserves consideration in other parts of the UK, coupled with financial incentives to aid good maintenance. Perversely, the few grants offered today often seem to reward neglect by targeting buildings suffering from grievous disrepair.

Daily care may lack the drama of rescue but as Morris well understood, it is the essential discipline for decay prevention.

National Maintenance Week takes place this year between 23 and 30 November 2012. For further details, see ***www.maintainyourbuilding.org.uk***

Neglecting simple tasks, such as gutter clearance or redecoration, leads to more work and greater expense in the long run.
© SPAB

Understanding Materials

Effective repair depends on understanding why a building's materials have decayed – and what can be done to prevent that happening again.

Understanding how a building works and why its materials are starting to fail depends on conservation specialists – people who are familiar with its construction and the reasons for its decay. It will often also call for a detailed examination of all the evidence to hand, both written and oral, selective testing and – most commonly of all – monitoring of the building's conditions over time.

Before any monitoring is deployed it is essential to establish the questions that need to be answered, as well as to secure the support of experienced specialists to interpret the resulting information. A complex problem on a significant building might call for monitoring of internal and external conditions over a period of a year and often longer (Curteis and Pender pp 18–21). However, the same underlying principles also apply to more straightforward monitoring (Wood pp 14–15; Viles pp 27–8).

Much of the research work undertaken by the Building Conservation and Research Team involves complex problems that require a combination of laboratory and site testing as well as detailed monitoring. While a great deal of useful information is acquired, solutions can nevertheless be elusive (Pinchin pp 12–14); on the other hand, there have been many practical successes (Viles pp 27–8; Stewart p 32). On rare occasions detailed research has shown serious flaws in the design and construction of iconic masterpieces such as Castle Drogo (Inskip pp 33–4).

Particularly important today is research into energy efficiency (Rye pp 22–3; Rhee-Duverne pp 23–4), which shows that old buildings perform much better than presumed and that improvements do not need to wreck their appearance or jeopardise vital fabric. Equally important are studies into the sourcing of appropriate materials for repair (McAlester pp 24–5; Brookes p 26; Letch pp 28–9).

Preventing rapid weathering of magnesian limestone buildings

Sarah Eleni Pinchin

PhD student sponsored by English Heritage, Faculty of Engineering, University of Nottingham

In an effort to improve the longevity of Magnesian limestone in historic buildings, the Building Conservation and Research Team at English Heritage, the Getty Conservation Institute and Princeton University collaborated on a project to examine the causes of deterioration of the stone, focusing on the example of the ruined 14th-century chapter house of Howden Minster in the East Riding of Yorkshire.

Decay

Magnesian limestone is a soft, cream-coloured stone that was used to construct many of northern England's monumental medieval buildings, including York and Beverley Minsters, Ripon Cathedral and Fountains Abbey. English Heritage's Conisborough Castle, Bolsover Castle, Brodsworth Hall and Howden Minster are all constructed of the same stone. Its suitability for carving also inspired its use for Sir Charles Barry's 19th-century rebuilding of the Houses of Parliament in Westminster, although its instability quickly led to a search for an alternative source of stone.

Magnesian limestone is prone to severe decay in the form of fracturing, contour scaling and erosion. In sheltered areas of a building, deep cavernous hollows are regularly found. The susceptibility of the stone to decay varies, in part because the composition of the stone is so variable, ranging from very fine-grained homogenous mudstone to a coarse stone with irregular shell inclusions.

The excessive decay is primarily due to the behaviour of magnesium and calcium sulphate salts, generated by the chemical reaction of the stone to acidic air pollution, which reached its

The staircase in the chapter house at Howden Minster exhibits particularly severe cavernous decay.
© Sarah Pinchin

Protective shelter-coats have been tested to stabilise the flaking areas at Howden Minster.
© Sarah Pinchin

peak during the industrial revolution. Sulphates from atmospheric pollution, deposited on the surface, formed a uniform black crust that did not cause additional damage until disrupted by deterioration, or intentional cleaning with water. Despite improvements in air quality, historic photographs reveal that the rate of stone loss on buildings has not decreased. High levels of magnesium sulphate salts found in the stone at Howden Minster may relate to its proximity to Drax, one of the largest coal-burning power stations in the UK.

Conservation and repair

Conventional stone conservation treatment involving consolidants (which stabilise friable surfaces by replacing the binder and re-adhering the particles) has not been successful in mitigating the decay of magnesian limestone. Tests of consolidants made over 15 years ago were reassessed by the project team and found to have no discernible effect on the surface erosion of the stone.

Repair of magnesian limestone buildings has traditionally involved the removal and replacement of failed stones, a costly undertaking considered feasible for individual blocks of stone, but less appropriate in the case of irreplaceable historic carvings and decorative features. Sourcing magnesian limestone that will visually match and weather in an identical manner to the surrounding material is not an easy task. The quarries from which the stones were originally sourced are rarely still active and therefore replacements are seldom available. The stone itself is so variable that even if there is an accessible bed with the correct characteristics, it is often difficult to extract enough to meet the high demands of the historic building.

At Howden Minster, the first step was to characterise the properties of the stone in the Chapter House to assess whether newly dug local stone would be a good match. The tests examined colour, pore structure and durability to soluble salts.

The most important property of the replacement stone is that it will weather in a similar way to the original and not put additional stress on the surrounding original stone. In order to select the best stone, it was necessary to find out more about the causes of the original decay.

Causes of damage

Conservators carried out a condition survey of the stone *in situ*, documenting the nature of the damage and assessing how the blocks concerned may have been affected by exposure to moisture paths, direct sunlight or excessive air movement.

Photographs were taken at regular intervals to understand the progression of damage. These successive images allowed researchers to understand that the decay was active and occurring several times every month. A time-lapse camera subsequently revealed that flakes of stone were lifting from different blocks of a wall at the same time. By comparing the timing of the damage with information from a weather station on the roof and environmental sensors on the walls it became apparent that flakes fell when moisture in the air condensed on the cold surface of the stone.

To understand what initiated the damage cycle, new blocks of stone with the same mixture and concentration of salts as stones from the building were subjected in the laboratory to the same changes in humidity that had been recorded on site, and within three months started flaking.

Testing treatments

In an effort to devise a way to remove the salts in the stone, a cellulose and clay poultice was put on the east wall of the chapter house. Salt-content analysis of drilled samples of the stone, before and after this treatment, revealed that the immediate effect of the poultice was to drive the salts deeper into the stone. The level of salt at the surface of the stone was reduced, but one month later, the concentration was the same as before treatment.

We also built an enclosure in an attempt to limit the humidity changes around the stone and in turn control the movement and crystallisation of salts.

We carried out treatment trials to shore up and protect the friable surfaces. These involved mortar repairs and the application of protective sheltercoats (which act as sacrificial surface layers) containing three different binders: calcium lime, magnesium lime, and hydraulic lime (NHL2). We also tested consolidation by recarbonating a thin layer of the stone with hydroxylating conversion treatment (HCT). The mortar repairs performed well as did the calcium lime mortar sheltercoat; however, none of the sheltercoats lasted for more than six months.

Future work

This informative study has posed many new questions about the damage mechanisms and treatment options that the international team of project participants will continue to explore. English Heritage hosted a one-day symposium in York in 2007 to discuss the lessons learned with other architects, conservators, material scientists and stonemasons and repeated the event in September 2012.

Damp towers

Chris Wood
Head of Building Conservation & Research, English Heritage

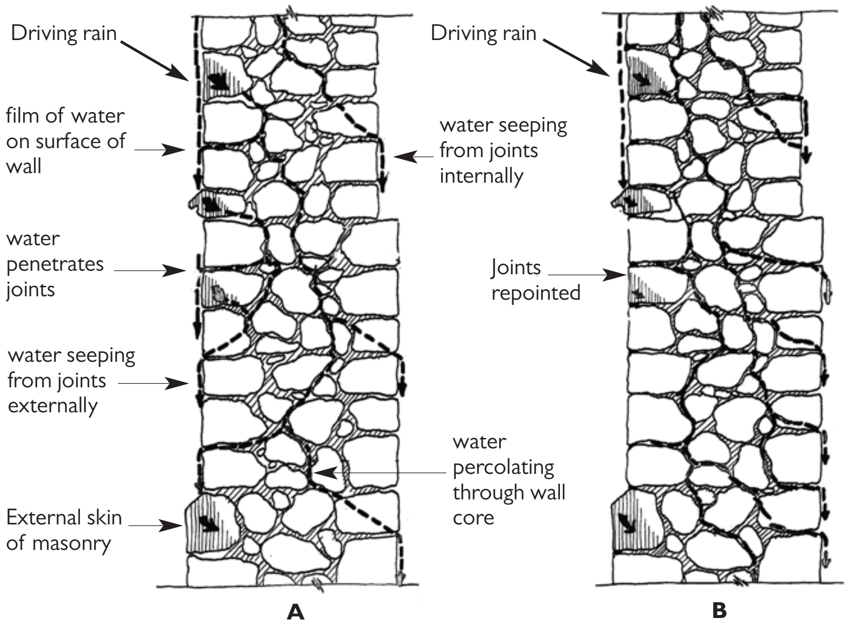
Damp interiors and very wet walls are a problem for many churches towers, particularly those that suffer from wind-driven rain. Analysing and remedying the faults is not easy; indeed a number of otherwise exemplary repairs have resulted in the ingress of water being worse than before. Not only is this very demoralising for those looking after and worshipping in the church, it is also extremely expensive. In an effort to better understand the problems and offer guidance on remedial works, English Heritage has carried out a major research project over the last 15 years, the results of which are to be published next year and will be the subject of a forthcoming conference (see below).

The research was centred in the south west of England, where the problem is worst. A number of towers were monitored before, during and after repairs. Others were simply observed and their performance during and after rain was recorded. This was supplemented by large-scale laboratory testing at Sheffield Hallam University, in which facsimile walls were subjected to driving rain in a controlled environmental chamber, and smaller-scale tests at the University of Oxford into the performance of different remedial mortar mixes.

Historic masonry walls

A well-constructed composite solid wall built with lime mortar will not leak on the inside. This adage was proved in the course of the Sheffield experiments: when two 'model' walls were totally saturated there was no leakage, but when voids were introduced, the water conducted through relatively

Holy Trinity, Challacombe, where re-rendering of the tower has turned a damp and uncomfortable interior into a dry and welcoming one.
Brian R Screaton © Images of England (98553)



Cross-section (A) through a rubble-cored wall showing potential routes for rain to track through the core and discharge both outside and inside. After re-pointing (B) the filling of the external exit points increases the amount discharged internally. Re-pointing alone is inadequate where the wall is subject to driving rain and voids exist a few millimetres behind the face.
Chris Wood © English Heritage

quickly. Filling the wall voids with grout stopped the water conduction. An external render was equally effective, holding most of the water until the rain stopped and natural evaporation could occur. Plastering the inside of walls with a lime-mix was also very effective at holding excess moisture.

All towers probably resisted rain ingress very effectively when first built. However, over the centuries they will have weathered, decayed, suffered periods of poor maintenance and been altered or badly repaired. As a result, many no longer have protective renders and plasters or will have suffered some wash-out of their cores, resulting in the formation of voids which can trap water. Many will have been re-pointed with hard cement mortars that prevent the escape or evaporation of water once they crack. Sometimes individual stones will have been replaced with non-matching alternatives, the different permeability and porosity of which also encourage water retention. Determining what is wrong with a tower is not easy, as it is often necessary to investigate the condition of the core. This can only be done by removing stones or applying other invasive methods, and even then the sample area may not be typical of the whole structure.

Repair options

The research project examined the main repair options, presuming that obvious faults to roofs or parapet walls had already been rectified. Re-pointing in lime mortar is the most popular choice, as it retains the appearance of the masonry and is cheaper and less invasive than grouting or rendering. However, a lot is being asked of a new mortar if the exposed faces of a church can suffer days of consistent driving rain. As the diagram shows, it is sometimes not possible to re-point to a sufficient depth to prevent water from continuing to permeate to the inside. Because re-pointing has filled the empty joints, more water now finds its way inside the church than before, despite the work being done to a high standard. However, the Oxford research showed that the speed of moisture absorption and evaporation can vary considerably depending on the materials used. It was also noticeable just how effective some of the Roman and early medieval mixes were in this respect.

A 'model' grouting exercise was subsequently carried out at St John the Baptist Church, Stowford, on the edge of Dartmoor (see Burns p 16). The church remains dry and comfortable and moisture levels in the wall are normal for a tower in this location.

At Holy Trinity, Challacombe in Exmoor, the very wet tower was allowed to dry for 18 months, before being rendered again for the first time in more than 150 years. The result has been a transformation from an extremely damp interior with mould on all walls, to a dry, relatively warm and pleasant environment. Ten years of monitoring has confirmed that moisture in the tower fluctuates with the amount of rainfall, but this is not causing any problems to the fabric or the comfort of the congregation.

A conference on the Damp Towers research is taking place on Tuesday 15 January 2013 at the Rougemont Hotel, Exeter. For further details contact ***conservation@english-heritage.org.uk****.*
The cost is £45.

Grouting the tower

Colin Burns

Tutor, West Dean College & formerly Building Conservation & Research, English Heritage

The Damp Towers research project (see Wood, pp 14–15) demonstrated the importance of using appropriate materials and techniques to determine the causes of the problem as well as to effect a satisfactory repair. Of course, good workmanship, following best-practice principles, is also essential if these objectives are to be realised. Reasonable guidance is available for the techniques of pointing, rendering and plastering but very little exists for grouting. To remedy this, grouting tests were carried out on facsimile ruins at the former English Heritage Training Centre at Fort Brockhurst, Gosport, and later at Sheffield Hallam University prior to a full-scale exercise on a church tower on Dartmoor.

The unique advantage of the purpose-made composite walls at Gosport and Sheffield is that they can be taken down at the end of the experiment to see how effective the grouting was in filling the voids. Very few people who carry out this work have the opportunity to see the result, as the whole point is to fill voids without removing facework. The aim of the tests was therefore to develop techniques that would ensure that all voids are successfully filled with grout, even when they cannot actually be seen.

At St John the Baptist Church at Stowford, on the edge of Dartmoor, severe driving rain was causing water to flow to the inside. Remedying this problem provided the opportunity to apply these principles in practice. The repairs were substantially grant-aided by English Heritage, which allowed unusually close involvement with the contractor in the trialling of the methods and the training of the team.

The project emphasised the importance of good practice, especially the need for careful investigation of the structure, including its construction, materials, alterations and maintenance regimes. Often this means carrying out invasive investigations, which proved essential at Stowford. Later 19th-century correspondence from George Gilbert Scott implied, erroneously, that the tower had recently been refaced in a form of cavity construction. Although heavily voided, it was in fact a solid structure.

The work also demonstrated the importance of determining the extent, position and connections between voids and the need to thoroughly prepare the core of the wall prior to grouting. This usually meant completely flushing out loose material with a hose and ensuring all voids were accessed. A carefully designed lime-based grout, capable of reaching and filling all voids and fissures without excessive shrinkage, was used. The grout mix needed to be varied depending on the ease of penetration and size of voids. The whole procedure is one of constant adjustment dependent on the particular circumstances of each particular part of the wall.

St John the Baptist, Stowford, Devon: determining where the voids are in the wall – a difficult and arduous process trying to drill through a granite core.
Chris Wood © English Heritage

Perhaps the most important requirement is to have a well-trained team, who are able to adapt their techniques to particular circumstances. Allowance for this, as well as some trialling, needs to be made in the specification and building contract.

The grouting proved to be successful. Water penetration ceased and subsequent monitoring has shown that although moisture levels rise in the wall after rain, these rapidly dry.

Lime mortars: evolving policy and practice

Alison Henry

Building Conservation & Research, English Heritage

Many traditional buildings were constructed using lime mortar, which is generally softer and more permeable than modern cement-based mortar. When repairing such buildings, it is important to use mortar with similar properties to the original, as this will accommodate any slight movement in the structure and allow any moisture to be dissipated harmlessly.

The preparation of the *Mortars, Renders & Plasters* volume of *Practical Building Conservation* provided an opportunity to review the development of policy and practice in this field over the last 25

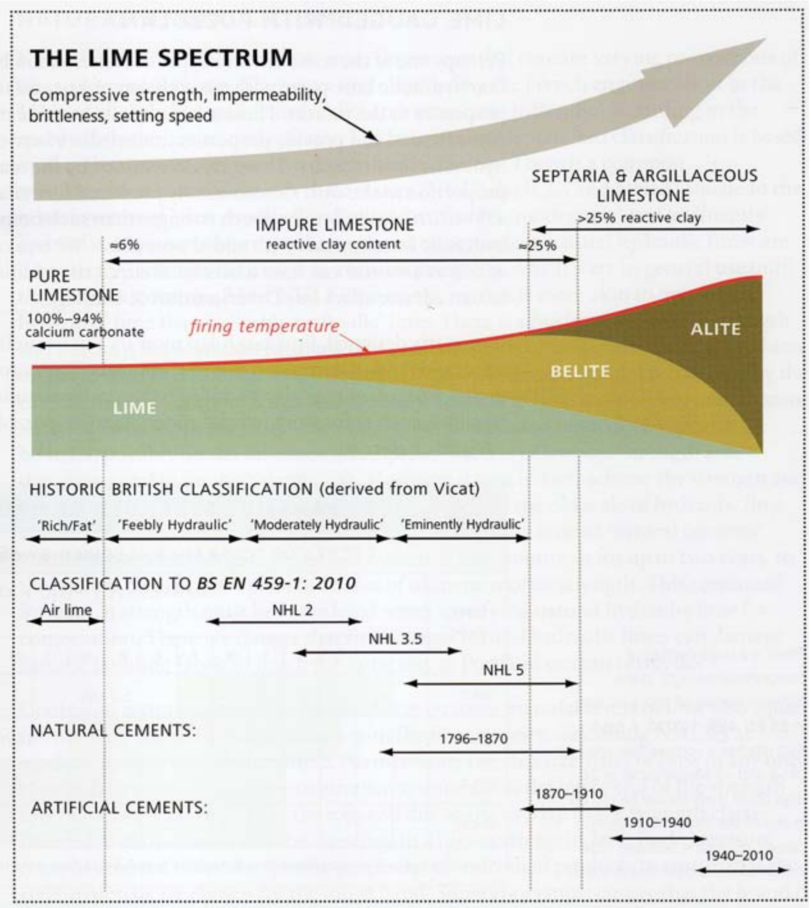


Diagram showing how the compressive strength, speed of set and permeability of historic and modern limes are related to the mineral content of the parent limestone and to burning temperature. There is a gap in the spectrum of modern limes that comply with BS EN 459, where feebly hydraulic lime used to sit. On the whole, the modern materials are significantly stronger than their historic counterparts.
© English Heritage

years. Drawing on research by English Heritage and others, and evaluating the success of work undertaken during the last quarter of the 20th century, it became evident that there were several areas in which best practice had evolved since the first edition of the book was published in 1988.

One of these concerns the types of mortar binder considered appropriate for different purposes. Until the early 19th century, when mortar with enhanced durability was needed for use in exposed environments or for engineering works, basic non-hydraulic lime (ie lime which hardens very slowly by reaction with the air) was modified by adding a pozzolan (a reactive clay material, which increases the speed of set of the lime and enables it to harden even under water). This practice subsequently declined in favour of natural hydraulic lime (ie a naturally occurring faster-setting lime that hardens partly by reaction with water), which in turn faced increasing competition from Portland cement, particularly after the Second World War. By the time UK production of hydraulic lime ceased in the 1970s, knowledge of the use and potential of pozzolans was all but lost. When lime mortar with hydraulic properties was required for building conservation it was instead achieved by gauging (ie blending) non-hydraulic lime with cement. The first edition of *Mortars, Plasters & Renders* recommended cement-gauged mixes for some purposes, in recognition of the limited availability and experience of alternative materials at that time. However, later research showed that the addition of small amounts of cement to non-hydraulic lime mortar resulted in a weaker mortar. Furthermore, the soluble salts contained in cement can cause damage to historic fabric.

The early 1990s saw increasing imports of natural hydraulic lime from the continent, followed in 1994 by a renaissance of UK production with the establishment of a lime works in an old Somerset quarry. At the same time, the experience of using non-hydraulic mortars gauged with pozzolans, gained during the conservation of the west front of Wells Cathedral in the 1970s and 1980s, began to be applied to mortars used for more general conservation purposes. English Heritage and others carried out extensive research into pozzolanic and hydraulic limes during the 1990s, which improved understanding of their properties and performance. Since then, natural hydraulic lime and pozzolanic lime have been increasingly specified for conservation. There is now a broad array of building limes and pozzolans available in England, and appropriate hydraulic properties can be obtained without the risks associated with adding artificial cement to lime.

However, there are significant differences between modern hydraulic lime and its historic counterpart. Throughout the 19th and much of the 20th centuries hydraulic limes were assigned to three classes, termed 'feebly hydraulic', 'moderately hydraulic' and 'eminently hydraulic', based largely on the speed at which the lime set underwater. The current British Standard (BS EN 459–1:2010) also comprises three classes (NHL2, NHL3.5 and NHL5), but based on minimum compressive strength of test mortars after 28 days. It is commonly thought that the modern classes equate to the historic ones, but this is not the case.

Non-hydraulic lime and the weakest lime in the current Standard, NHL2, differ considerably in terms of strength and porosity. This leaves a gap in the current classification of lime binders that was previously filled by feebly hydraulic lime. Feebly hydraulic lime was probably the type most widely used for general building in the past, but the British Standard makes no provision for it, and consequently manufacturers are reluctant to produce it.

Specifiers and practitioners using NHL2 in the belief that it equates to feebly hydraulic lime will almost certainly be employing a significantly stronger and less permeable material that is closer to the moderately hydraulic lime that was historically used for foundations and engineering works.

Nowadays, NHL3.5 is probably the most widely used natural hydraulic lime binder, perhaps on the assumption that, being the middle class of the three, it is somehow of 'average' strength and therefore suitable for the 'average' job. However, most NHL3.5s are likely to have properties closer to traditional eminently hydraulic lime than to moderately hydraulic lime.

Confusion is compounded by the fact that even suppliers often use the historic terms incorrectly. A large overlap between the three strength classes in BS EN 459 causes further uncertainty, with the result that some types of lime could legitimately be placed in two or even all three classes. Where particular properties are required, a named brand and class should be specified and supervisors should ensure that it is actually used on site and not replaced by another brand that might be much stronger than needed.

Another area where practice has evolved since the 1990s is in the blending of hydraulic and non-hydraulic lime. There is no historical precedent for this, and it was a response to a lack of limes offering the full range of strength and permeability characteristics. The objective was to improve the workability and decrease the strength of the hydraulic lime available at the time (there were concerns even then that hydraulic limes were excessively strong for some conservation applications).

However, the properties of such mortars proved hard to predict and there were some severe failures. Subsequent tests showed that they had reduced resistance to frost and salt crystallisation. It is now possible to achieve appropriate strength and setting characteristics from the natural hydraulic limes on the market or by adding a pozzolan to a non-hydraulic lime, while workability of natural hydraulic lime can be improved by mixing the mortar with a power blender to entrain air, and by adding small quantities of crushed stone to increase plasticity.

The new edition of *Mortars, Renders & Plasters* places great emphasis on selecting mortar mixes which reflect the type of masonry (whether tough or weak), its condition and its exposure. For those applications where a weakly hydraulic mortar is appropriate, the correct strength and permeability can be achieved by gauging non-hydraulic lime with pozzolan. Where greater strength is required NHL2 may be appropriate, whereas NHL3.5 and NHL5 should be reserved for tough masonry in good condition in exposed locations.

It is important to understand the properties of different binders in order to select appropriate materials for conservation of historic fabric. It has long been recognised that cement mortar can trap moisture in the stonework and lead to deterioration of the stone itself, as shown here, but strong hydraulic lime can also harm fragile stone and mortars.
Alison Henry © English Heritage

Using environmental survey and monitoring as a conservation tool

Tobit Curteis, *Tobit Curteis Associates* and Robyn Pender, *Senior Architectural Conservator, English Heritage*

Over the course of the 20th century, as the processes of deterioration began to be better understood, it became clear that short-term approaches to dealing with historic buildings and their contents – stabilise fragile areas, treat the damage, and make everything superficially appear to be in good condition once more – had long-term consequences. At the very least, they diverted resources away from dealing with the causes of the damage, and at worst they could actively exacerbate deterioration. From 'restoration' developed 'conservation', which aims to preserve objects and buildings in the best possible condition by halting or at least slowing decay, and to do this by identifying and resolving the underlying problems.

The more that is discovered about the deterioration of building materials and systems, the clearer it becomes that the critical factor is the building environment: the complex and unique system composed of the structure itself, the landscape that surrounds it, the weather to which it is exposed, and the internal conditions resulting from the way it is being used.

Over the past three decades building diagnosis has developed from infancy into a serious and well-established discipline, with an armoury of tools and techniques. One of the most important of these is environmental monitoring, but it is also one of the most poorly understood. Effective monitoring rests on a clear understanding of its part in the overall process of building diagnosis.

Sensors monitoring relative humidity, temperature, light, UV radiation and movement on the Black Prince's tomb at Canterbury Cathedral. © Tobit Curteis

Building diagnosis

Undertaking a survey purely for interest's sake is not entirely unknown, but as a general rule building diagnosis is commissioned for one of three reasons: because users have noticed damage or deterioration of the building, or some important part of its contents; or because there are plans to alter the building or the way it is being used; or because the building is changing hands. For historic buildings, one of the most common situations is that heating or ventilation alterations are being proposed as part of a wider scheme of refurbishment and re-presentation.

When a building manager calls in a specialist in environmental diagnosis he or she should be prepared to think very clearly about what questions to ask, and what answers are wanted. The specialist will wish to discuss not only the reasons behind the investigation, but also the building itself: its general condition, the history of the deterioration, the plans that are being made for its future.

Weather station monitoring the external conditions at Canterbury Cathedral. © Tobit Curteis

The next step is the most critical: a preliminary assessment of the building itself. This may reveal the underlying causes of the deterioration to be simple and controllable, in which case the investigation need go no further. It will certainly answer many questions, but it may also reveal some important unknowns – perhaps detailed issues about the building or its materials that cannot be answered without closer access, or sampling and analysis.

In many cases the most important questions will concern the way the building is interacting with its environment, and it is for addressing these that environmental monitoring can be invaluable. For example, if alterations are being contemplated, monitoring can begin by revealing how the environment is currently operating, and then go on to serve as a baseline against which to compare conditions after the proposed interventions have been made.

The great power of monitoring is that it moves conservators and building managers away from thinking about absolute measurements (for example, of moisture content), which can be both very difficult to obtain and very deceptive, towards the much more useful consideration of change: and it is change that causes deterioration.

Designing an environmental monitoring system

With so many factors at work – from temperature and humidity to light levels and air movement, to mention just the most common – which parameters will need to be monitored, and where? It is here that the expertise and experience of the specialist are vital; although it is now fairly simple to buy monitoring equipment, the skill lies not in installing or downloading, but in designing systems, and analysing and interpreting results. Specialists in environmental monitoring need backgrounds not in technology, but in conservation; and preferably of the type of building or material they have been called in to study.

There are no 'standard' monitoring systems. Instead, the specialist must develop a hypothesis of how the building is behaving, and what the critical factors seem likely to be, which the monitoring programme is then designed to test and refine. As well as the usual electronic monitoring of temperature and humidity parameters, it may be necessary to consider techniques such as time-lapse photography, or even to develop innovative sensors. There are some general rules, however, that apply in all systems, including always recording in comparable locations, and always collecting data outside the building as well as inside.

In theory the minimum period for monitoring is 12 months, to capture all the seasonal changes, but this is not always possible for logistical reasons, so some flexibility may be needed. The sooner the equipment can be in place collecting data, the better. For buildings that are likely to face repeated changes (cathedrals, for example, which must cater for alternative uses such as concerts and ever-increasing demands of comfort), it is advisable to consider installing a monitoring system that can record data in anticipation of future utility. In the meantime, it allows the building managers to hone their understanding of how the building behaves, which will be invaluable when it comes to designing effective alterations, as well as managing energy use. The same system may also be used to monitor the conditions after an intervention, to see whether it has had the desired effect (and facilitate fine-tuning if it has not).

Specialists should be consulted in order not only

Assessing innovative conservation systems

Stained glass can be one of the most evocative but fragile survivals of early building decoration. One of the few effective methods of conserving important glass *in situ* is protective secondary glazing to protect it from rain, wind, impact and, most importantly, condensation on the inner painted surface.

Monitoring the microclimate as part of a research project on protective glazing commissioned by English Heritage at Long Melford Church in Suffolk.

The potential disadvantages include the creation of an unfavourable microclimate in the space between the two glass layers. Protective glazing systems involve the installation of a second layer of glass on the exterior of the window creating a buffering air space that is vented to the interior or the exterior. The system relies on differential air temperatures between the air space and the internal or external air mass to effect changes in relative air buoyancy.

Environmental monitoring is now regularly employed to examine the patterns of deterioration and to assist with the design of efficient and discrete protective glazing systems. One such example is in Holy Trinity Church at Long Melford, Suffolk, where the nationally important 15th-century glass is deteriorating severely as a result of moisture issues and microbiological growth.

The Canterbury Cathedral Stained Glass Studio has constructed a number of test areas of protective glazing and environmental monitoring is being used to establish the current microclimate in the vicinity of the glass, the way in which the protective glazing alters this, and the efficacy of the different designs (including the depth of the air gap between the two layers of glass, and the design of the vents).

to design the best system for collecting data, but also to develop an effective means by which the building manager can access the results. Data is not information until it has been interpreted, and this is the final and most critical role of the diagnostic monitoring specialist.

Turning data into information

Interpretation is the greatest challenge of monitoring, even when the data is apparently straightforward, and can be easily presented as graphs. The final choice of parameters to compare and contrast in an environmental monitoring report is the result of many hours of examination and analysis, during which the specialist revisits the hypothesis and refines his or her view of the building and its conservation issues.

One of the essential difficulties is linking cause to effect: even where a physical change can be monitored (perhaps the movement of a crack with a strain gauge, or the loss of a paint flake with time-lapse photography) the link to a change in one or more environmental parameters can be hard to prove. Again, the specialist must often draw on his or her knowledge and experience of other buildings and understanding of the mechanisms of deterioration and decay. Finally, conclusions must be expressed clearly, and the original questions asked of the study revisited, so as to answer them in ways immediately useful to the building manager.

Conclusion

Environmental monitoring is expensive and time-consuming, and if poorly designed will be ineffective at best, and misleading at worst. On the other hand, used where it is really needed, and designed well, it is one of the most powerful tools for understanding complex building systems, and planning for their long-term preservation.

The forthcoming *Building Environment* volume of the English Heritage *Practical Building Conservation* series includes a detailed discussion of the mechanics of environmental monitoring.

Diagnosing complex deterioration

By tracking events that happen rarely or unpredictably, environmental monitoring can provide the key to otherwise inexplicable deterioration.

Light falling across the 15th-century wall painting at Cleeve Abbey.

An important 15th-century wall painting in a first-floor room of Cleeve Abbey's south range had suffered for many years from a unique form of deterioration that resisted every attempt at diagnosis. Spalling and losses of the plaster were known to be associated with the inclusion of dark flint particles, but it was not clear why damage had occurred only since uncovering, nor why it was restricted to one band across the painting. Standard monitoring systems recording temperature and humidity failed to isolate the underlying cause, even when combined with time-lapse video microscopy.

It was only when large-scale time-lapse imaging was used for a complete year that the cause was revealed: for a number of weeks in winter, the sun is low enough to penetrate the window of the chamber and strike the wall, and the pattern of exposure coincides with the pattern of damage. The problem can therefore be traced to solar radiant heating causing thermal expansion of the flint, and can now be controlled by covering the window for this period of the year.

The monitoring also revealed that the high level of air exchange with the adjacent passage (itself open to the exterior) causes highly unstable conditions that result in condensation and salt activity. It has therefore been possible to prevent further deterioration simply by installing clear panels in the openings to reduce air exchange.

Heat loss, walls and traditional buildings

Dr Caroline Rye
Managing Director, ArchiMetrics Ltd

In 2009 I began to measure, *in situ*, the U-values (ie standard measures of heat loss) of traditionally built walls. This work was done on behalf of the SPAB under the guidance of Dr Paul Baker of Glasgow Caledonia University. Measurements were carried out on a variety of walls including ones made of stone, brick, cob and timber-frames. As well as measuring the degree of heat loss through these elements I decided to also *calculate* U-values for these same walls as I was interested to compare the two sets of figures. This comparison produced a startling result – the heat loss of these walls was overestimated by the standard calculated U-value in 73% of cases (see diagram). These findings were later confirmed by a similar comparison carried out by Dr Baker on samples of stone walls in Scotland and by more recent work for English Heritage on solid brick walls.

The discrepancy between calculated and measured U-values of solid walls has serious consequences; wall U-values are a key component in the estimation of whole building heat loss and subsequent estimates of stock and building energy performance. They are also the means by which measures for upgrading the walls of existing buildings are determined – the target currently provided in Approved Document Part L of the Building Regulations is 0.3 W/m2K. This means 0.3 watts of energy is lost through 1 sq m of the wall or window with a temperature difference of 1° C between the outside and inside.

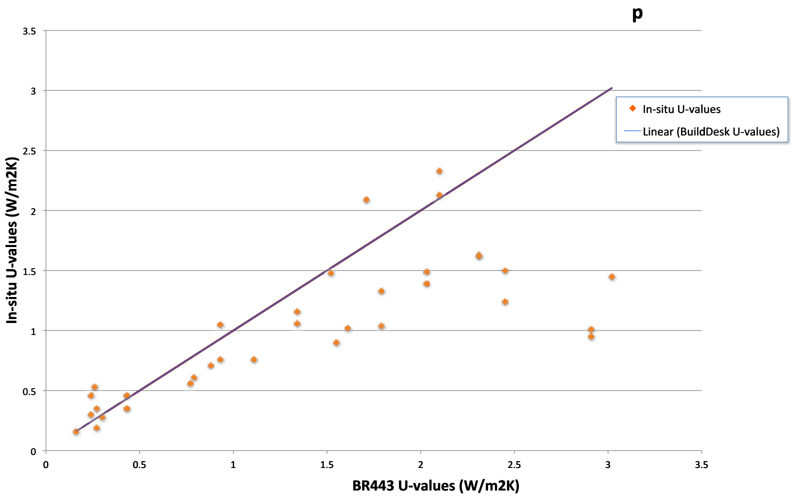
The misapprehension of the U-values of pre-1919 walls leads to a misunderstanding of their actual energy performance and results in formulations which rate this part of the building stock as the worst performing of all age groups. By over-estimating the degree of heat lost through these solid walls we risk wasting resources and causing potential damage; first through the specification of high-performance, vapour-closed, insulation materials to achieve wall-improvement U-value targets and secondly by misdirecting refurbishment resources. This is true not just for individual buildings but also for all of our pre-1919 stock of buildings via the policies and specification processes underpinned by energy performance assessments.

How, therefore, should building professionals work with the knowledge that a calculated U-value may not be a good representation of heat loss for a solid wall? In this context it is worth considering the U-value calculating procedure itself. A U-value calculation (following BS 6946:2007) assumes that all elements of a wall can be properly defined and given their correct thermal attributes. This is straightforward with a cavity wall where the different leaves are easily identified and the material conductivities of modern building materials well known. However, in an existing wall it is difficult to deduce the exact types and quantities of materials, including mortar and voids, involved in its build up. In addition there are very few root thermal conductivity data for historic UK building materials.

The most straightforward solution to overcome the 'unknown' nature of an existing solid wall is to measure its U-value *in situ*. However, this process is time consuming and can only be undertaken in the winter months so is not a realistic option for most buildings (although it should definitely be considered for buildings of significance which are the subject of major refurbishment programmes).

The U-value calculating programme BuildDesk has gone some way to address concerns by providing in its software mortar fractions that are representative of historic brick bonds. The generally poor quality of data about the properties of most traditional building materials, plus the complexity of modelling a traditional wall, nevertheless mean that there continues to be a great deal of uncertainty in a calculated U-value for these walls. There

The author applying heat flux sensors to a wall to take an *in-situ* U-value measurement.



Graph showing the comparison of measured (straight line) and calculated U-values (points) for solid walls. The majority of the points (73%) fall below the calculated U-value line indicating a lower degree of heat loss from the measured data.

are, however, limited data tables available of measured U-values from work done by the SPAB, Historic Scotland and English Heritage and these should be consulted to establish a likely range of U-values for walls of similar types and construction (Rye 2010; Baker 2011; Baker and Rhee-Duverne 2012).

The Sustainable Traditional Buildings Alliance (STBA) is currently working alongside DECC and DCLG to improve upon the conventions that govern the calculation of U-values to the benefit of traditional buildings, particularly in view of the imminent launch of the Government's Green Deal refurbishment programme.

The Sustainable Traditional Buildings Alliance is an alliance of historic building groups, including English Heritage and other environmental and professional building organisations. For more information got to ***www.stbauk.org***

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The carbon challenge for traditional buildings

Soki Rhee-Duverne

Researcher, English Heritage

Traditional buildings are a significant resource and a vital part of our heritage. However, there is a common perception that they are draughty and energy inefficient. Global pressures to reduce energy use and greenhouse-gas emissions and a UK commitment to an 80% emissions reduction by 2050 from 1990 mean that efforts to improve the energy efficiency of our existing buildings are intensifying.

English Heritage is concerned that ever-more stringent targets to improve the energy performance of all dwellings may lead to inappropriate and potentially damaging work to traditionally constructed homes. The reason for this concern is that there is lack of evidence about the actual thermal performance of traditional buildings. With this in mind, English Heritage has commissioned from Glasgow Caledonian University a wide-ranging programme of research to fill this knowledge gap. The work has focused on traditionally constructed pre-1919 brick dwellings, not only because this is the predominant building type in England but also because it is has been perceived as the worst performing.

The aim of the research is to use a combination of fieldwork, modelling and laboratory testing to develop a sound evidence base for thermal performance. As well as allowing better-informed decisions about improving the energy efficiency of traditionally constructed buildings it will also help us to predict their thermal behaviour with much greater accuracy. Three areas are being investigated: the thermal performance of individual building elements, whole-house thermal performance, and the impacts of modern energy efficiency interventions, including the technical risks associated with internal wall insulation.

There are many factors that affect the energy demand of a building, ranging from the way it is used, the heat-loss characteristics of its construction materials and the effects of climate, to air leakage rates, thermal storage capacities and the number of electrical appliances and lights that it houses. Of these, thermal transmittance of the fabric and heat loss through ventilation are the principal factors that determine energy performance. The BRE Domestic Energy Model, which underpins the UK Government's Standard Assessment Procedure for energy performance rating systems, relies on a set of assumptions about building performance. Our research is suggesting that these assumptions may not be a true reflection of actual performance and that more careful assessment is needed in the case of older buildings.

A comparison of the actual *in-situ* U-values (the standard indicator of how well the building element in question gains or loses) of 18 solid-brick walls with calculated and industry-standard values shows that on average these theoretical scores overestimate thermal transmittance by approximately a third. On average the *in-situ* U-values achieved 1.4W/m^{2}K, compared with the 2.1W/m^{2}K value recommended in official SAP (Standard Assessment Procedure) assessments. The initial results from whole-house performance tests carried out before and after the refurbishment on a 19th-century end-of-terrace brick house at New Bolsover confirmed these findings and suggest that a significant improvement can be achieved if measures are carefully targeted to the worst-performing elements of a building.

For instance, old and unsightly, single (rear) and double-glazed (front) plastic-coated aluminium windows were replaced with new single-glazed timber windows following the original design, supplemented by low-emission or vacuum secondary glazing. The new windows achieved centre-pane U-values of 1.6W/m^{2}K and 0.8W/m^{2}K respectively. These values satisfy the Building Regulations.

The findings from the thermal testing are encouraging. However, the application of internal wall insulation needs to be considered with care, given that the solid walls of traditional buildings are made of a permeable fabric that allows the transfer of water vapour. To make sure that this natural movement of moisture is not inhibited, with damaging consequences, there are strong theoretical grounds for favouring the use of a hygroscopic (ie moisture-absorbing) over a non-hygroscopic insulation system. To better understand the benefits and risks, both types have been installed at New Bolsover, where they will be the subject of long-term monitoring to assess the condensation risk at the interface of the fabric and the insulation system. This *in-situ* testing and monitoring is being supported by a parallel programme of laboratory work and modelling.

Ultimately, the findings from the research will be used to provide best-practice advice and guidance on the refurbishment and adaptation of traditional buildings, based on other criteria of cost, ease and practicability of installation, the technical risks and the impacts of heritage values and significance.

The front elevation of the New Bolsover test house showing the new single-glazed windows, which replicated the originals. Secondary glazing on the inside means that these windows are more efficient than most forms of double-glazing and are far more effective at reducing noise pollution.

The Strategic Stone Study – matching stone sources to end uses

Tarnia McAlester

formerly Strategic Stone Study Project Manager, English Heritage

Sourcing the right stone to conserve historic buildings can be extremely challenging. This is not solely a matter of aesthetics but also of technical compatibility, because any new replacement stone has to match the original not only in terms of its mineral composition but also its density and porosity (see Lott pp 5–7). If this rule is not adhered to, a superficially inappropriate new stone can hasten the decay of its older neighbour and is unlikely to 'weather in' consistently.

National policy

National and local planning regulations encourage the like-for-like replacement of stone for the repair of historic and traditional buildings as a way of supporting the market. In addition, new buildings and extensions, especially in conservation areas, will often need materials that complement those of the buildings around them. However, architects

The rear elevation of this roof in Shropshire has been repaired with traditional local slate, but the left-hand side with imported Indian stone. Not only are the replacements the wrong colour and size but there is no evidence as to how they will match the host stones in terms of durability and performance.
© Terry Hughes

cannot specify a matching stone if they cannot identify an available source for it. To obtain a proper match, new or replacement stone has to come either from the original quarry, or at least one in close proximity to the original supply.

The rich diversity of England's geology means that hundreds of different stones have been used over the centuries for building purposes. However, accurate information on the original quarries and the number and distribution of the buildings that were constructed from these stones is very scant.

The Study

The Strategic Stone Study (SSS) aimed to address these issues by comprehensively mapping all the active, dormant and historic quarries within England, identifying the building stones they provided, and matching them to buildings and structures.

Thirty-two English counties have been completed so far. Initially, the survey began with a commission from English Heritage for the British Geological Survey (BGS) to expand its existing database of quarries, mines and mineral workings in the UK (BRITPits) to accommodate the data on building stone resources. This new database is called English Building Stone Pits (EBSPits).

The methodology was straightforward: existing sources of information were supplemented by local knowledge and limited fieldwork, which were then entered into supplied databases, supported by county maps. English Heritage, BGS, local geological teams and historic buildings experts from across the country then worked together to fill in three spreadsheets to:

a) identify the most important stones used for building and roofing
b) select representative examples of villages, buildings and other structures built of those stones
c) identify active, dormant and historic building stone quarries
d) compile a written report or 'Atlas' on their findings to assist mineral planners, and anyone wishing to find out about building stone usage in a county.

Once the county data were completed and checked, BGS loaded them into the EBSPits website. The results are now freely available on a Geographical Information System (GIS) via the web and it is now possible to download the dataset for each of the 32 counties. As well as the photographically illustrated atlas, this dataset includes the three excel spreadsheets listing types of stone, examples of buildings and the location of quarries for each county. To access the datasets go to **www.english-heritage.org.uk/strategic-stone-study** and follow the link to British Geological Survey.

So far, 2698 building stones, 10,604 building-stone quarries, and 13,654 indicative stone structures (including 1254 predominantly stone villages) have been identified. Unfortunately, at present there is no funding to complete the study.

The database should help Mineral Planning Authorities (MPAs) identify and safeguard existing and potential building stone quarries so that policies will reflect the needs of building conservation alongside other development proposals and environmental designations (see Henry pp 43–4). Counties are already referring to the SSS in their core strategies (eg Somerset and Derbyshire) and further publicity is planned to alert mineral planners to what is available.

The hamlet of Ginclough, near Rainow in Cheshire, typifies the way a locally sourced sandstone underpins local character.
© Geckoella Ltd

Baddesley Clinton

The remarkably picturesque Grade I moated house, which dates back to the 13th century, was owned by the Ferrers-Walker family prior to acquisition by the National Trust in 1979. In 2009 the Trust received a bequest that allowed it to tackle the first phase of stonework repairs to the north-west gable.

Much-used in west Warwickshire and elsewhere, Arden Sandstone, of which the house is constructed, is quite distinctive in appearance. Fine-grained and buff grey, it has a characteristic veining that is associated with the weathering of the softer beds. Historically, Arden sandstone would have been locally sourced – no doubt from a number of sites, including a former quarry known as Badger's Dell adjacent to the main drive.

Sourcing the correct matching stone for repairs is a problem wherever historic sources of local stone are no longer commercially available. Stone from commercial quarries seldom offers a perfect match in terms of physical appearance, strength and porosity, and there are numerous examples of unnecessary disfigurement to historic buildings where insufficient care has been taken to specify a matching stone.

Arden Sandstone is subtly different in appearance from other Warwickshire sandstones, which tend to be fine-grained, red or buff in colour. There will always be concerns where commercially available mismatched and less porous stone is placed next to a softer and more porous local sandstone. These concerns relate not only to the visual appearance of the

The repaired north-west gable.
© Rodney Melville and Partners

The coffin-room window before and after repair.
© Rodney Melville and Partners

intervention but also to differences in strength and porosity that, over time, will generally result in accelerated decay of the local stone. Arden Sandstone is so unlike any commercially available stone that a search was begun for a local source that might be used for the repairs.

This process was spurred on by the enthusiasm of Jeremy Milln, then National Trust Regional Archaeologist, and the technical knowledge and unstinting commitment given to the project by Maurice Rogers in his role as the Trust's volunteer geologist. A preliminary dig at Badger's Dell established building stone at a fairly shallow depth and the local planning authority willingly agreed that the operation was *de minimis* and would not need permission. Quarry blocks were extracted of sufficient bed height for the repairs. Stone was removed in the traditional way using plugs and feathers prior to transport to a local saw yard.

Croft Building & Conservation Ltd were appointed to carry out the repairs, which were competently completed with a perfectly matching stone in October 2011.

Andrew Brookes, *Rodney Melville and Partners*

Soft wall-capping research

Heather Viles

Professor of Biogeomorphology and Heritage Conservation, University of Oxford

Ruined structures pose many problems for architectural conservation. Once the roof has been lost from a building, wall heads are exposed to the elements, in turn allowing valuable and historic fabric to deteriorate very quickly. How best to conserve historic ruins such as medieval abbeys and castles has been a long-term challenge for English Heritage. The conventional approach is to use 'hard capping', ie to create a mortar-based wall head to shed water and protect the underlying masonry. In the past, hard capping was carried out with very hard mortars that create a concrete-like finish incompatible with underlying masonry. This type of hard capping is prone to cracking, after which water can penetrate and cause accelerated damage. Recently, English Heritage, in its search for more flexible and robust conservation solutions for ruined wall heads, looked to nature for some better answers.

Under natural conditions, within England's temperate climate, ruined wall tops become rapidly colonised by a succession of plants. As well as contributing to the aesthetic beauty of ruins, these organic growths may also act as natural agents of protection from rain, frost and other agents of deterioration. Observations during conservation work by English Heritage at Wigmore Castle in Herefordshire revealed that natural 'soft caps' developed over previous centuries had not done any harm to the underlying walls, and after consolidation they were replaced to aid future conservation.

In 2004 English Heritage, in association with the University of Oxford, began the first comprehensive assessment of the role of soft capping on ruined walls, aiming to find out whether or not both naturally developed and human-emplaced soft capping have protective benefits (Lee *et al*, 2009). The research programme, now in its third phase, uses an integrated methodology that links laboratory experiments, field trials on a number of ruins in England and monitoring of specially built test walls at Wytham Woods, near Oxford, in order to provide a balanced assessment.

The soft-capping research project tests the following two broad hypotheses. First, that soft capping provides an effective thermal blanket, reducing the temperature ranges experienced at the wall head (and thus lessening the likelihood of damage through frost weathering and temperature cycling). Secondly, that soft capping has a moderating effect on moisture regimes at the wall head, reducing the amount of water entering the wall top, shedding water away from the wall face below and moderating wetting/drying cycles within the upper parts of the wall. Where possible, our tests have been designed to make direct comparisons between soft and hard capping. The research has also focused on practical issues of how best to implement soft capping, starting off with simple soil and turf caps and moving on to more drought-resistant caps using sedum plants.

We have found that soft capping provides a very good thermal blanket, not only in the field

Turf-based soft capping on the cloister walls at Hailes Abbey, Gloucestershire, photographed four years after emplacement as part of the soft-capping research project.
© Heather Viles

One of four test walls at Wytham Woods, near Oxford, capped with soil and turf, with drought-resistant sedum plants around the edges. Two of the walls are hard-capped, and two are soft-capped to enable direct comparisons

at Byland Abbey in North Yorkshire, but also in a range of laboratory tests under realistic climatic cycles, and in field exposure trials in Oxford. Even a thin soft capping (5cm of soil) has been shown to be more effective than comparable hard caps in reducing temperature fluctuations on underlying stone. Untangling the effects of soft capping on moisture regimes has proved more difficult. Results from field monitoring of moisture levels in walls under soft capping (using the wooden dowel method) at Hailes Abbey in Gloucestershire, and at Byland Abbey in North Yorkshire came up with divergent results. However, one general trend we found was that moisture regimes in walls under soft capping are less variable over annual timescales than those under hard capping. Using our specially built test walls at Wytham Woods, we have been able to study moisture regimes under hard versus soft capping in a much more controlled way, but the findings are complex and not entirely clear cut. At Godstow Nunnery near Oxford, trials of turf and sedum-based soft capping show that sedum caps are more resilient in the face of harsh winters and dry summers.

In summary, our research demonstrates soft capping to be an important conservation tool for the many miles of ruined walls around the country that English Heritage manages. Our research demonstrates many advantages of soft over hard capping and, crucially, shows that soft capping is usually considerably cheaper.

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Ensuring supplies of suitable thatching straw

Stephen Letch
Thatcher and grower, National Thatching Straw Growers Association

Concern over sufficient and suitable supply of thatching straw has been a topic of debate for decades; poor harvests due to bad weather, unsuitable wheat varieties being grown, reliance on vintage machinery, retirement of experienced growers and the premature decay of some straw thatch are often cited as justification for re-thatching buildings with allegedly more reliable sources of water reed, the majority of which is imported from eastern Europe and China.

A group of farmers and thatchers who grow their own thatching straw formed the National Thatching Straw Growers Association (NTSGA) in 2011 with very clear aims to reverse the decline and apparent bias against thatching straw and to promote its benefits for thatching. The plan was to achieve this by pooling extensive knowledge and experience of thatching and growing and by undertaking research on wheat varieties linked with crop husbandry and harvesting techniques. This project has attracted English Heritage funding.

A comprehensive project design was drawn up by the NTSGA for an initial pilot project in East Anglia, and trial cereal crop plots were planted in October 2012. Once the pilot project has been completed and refined, it is envisaged that the thatching straw research programme can then be rolled out to other regions of England and Wales. The pilot project comprises two work packages: (1) monitoring and detailed recording of the growing, husbandry and harvesting of the cereal crops; and (2) thatching small roof frames for long-term monitoring of performance and regular chemical analysis. Four growers, each with a different husbandry scheme, will plant five wheat varieties. The different husbandry regimes include high artificial fertiliser input, low artificial fertiliser input, residue fertility and organic. The five varieties are Squareheads Master 13/4, Yeoman, New Harvester, Maris Widgeon and Maris Huntsman, with one Triticale variety called Purdy as a comparator. The growers chose these wheats carefully because they showed good promise and consistency in trials at the John Innes Institute over a period of years. The aim is to have some or all registered as conservation varieties, which will ensure that a pure legal seed stock is available for growers to buy, give or sell.

Edward Impey, English Heritage's Director of Heritage Protection and Planning, working the traditional reaper binder on the author's crop of Triumph, one of the five varieties of long-strawed wheat being trialled by the National Thatching Straw Growers Association.
© Mike Ambrose

One key benefit of this research is that it may help determine which wheat varieties (primarily through the length of the straw stems) are best suited for different techniques and applications. For example, long straw is the main technique used in East Anglia where the roofs are steeper. By contrast, straw thatchers in the south west of England favour the use of combed wheat reed on the region's lower pitches. At present, straw-growing farmers and the thatchers who use the resulting material tend to have different objectives. The key concern for farmers is that the crop resists being beaten down by wind and rain, thus helping them produce consistent yields of quality thatching straw. To avoid crops lodging they tend to choose average as opposed to long-stemmed varieties of wheat or Triticale. For many thatchers, on the other hand, it is the handling characteristics of the straw that are paramount. Good length is what they prefer and some of them also believe that they will one day find the Holy Grail variety that will simultaneously improve the lifespan of their thatching.

Thatching the trial roof frames will be carried out using three types and specifications of long-straw thatching using material harvested from the trial plots. As East Anglia has no tradition of employing combed wheat reed prior to the 1960s, these pilot trials will be confined to long straw. It will be interesting to see over a period of years how the 144 thatch samples will perform. Hopefully it will help answer the significant question of what is the most important factor governing longevity: nitrogen content through crop husbandry, variety of wheat, or the thatching method and quality of workmanship. The samples that offer the most exciting possibilities are the ones that specify a thick coat of thatch made of longer-stemmed older varieties of wheat grown with a low nitrogen input. These may provide the answer to the problem of 'premature degradation', which has been recorded on some types of thatch, usually in the damper parts of England.

Successful thatching depends on not only the right materials but also the expert skills of a thatcher like Bodkin Willows.
© Stephen Letch

The decay of thatch, like that of all building materials, can be kept to a minimum by understanding the material to hand and how best to use it on any given roof – good thatch does not rot, it decays on the surface and gradually wears down over a long period of time.

Breathability in the very top surface of thatch is very important, to avoid moisture wicking up the stems to the thatch fixings. An over-tight thatch surface encourages excessive fungal and chemical decay, giving rise to 'premature degradation'. It seems to be too much of a coincidence that there were few recorded instances of this afflicting combed wheat reed thatch prior to the introduction of modern shorter stemmed wheat varieties. This, of course, is a controversial debate; the wider research project offers the potential to provide some clearer answers.

To find out more about the National Thatching Straw Growers Association and its projects go to ***http://www.ntsga.org.uk***

Architectural metalwork: conservation on and off site

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Building Conservation & Research, English Heritage

Architectural metalwork is enormously diverse, encompassing both structural and ornamental elements. Corrosion is a common feature of deterioration, whether caused in the first place by weathering, structural stress, sudden damage due to disastrous events, wear associated with heavy use, inherent weaknesses or ill-advised treatments or repairs.

When planning the treatment for architectural metalwork, it is critical to decide whether to carry out the works *in situ* or in a workshop. Each approach has its own benefits and disadvantages, and conservation works will often involve a combination of both.

Working on site would always be the first choice, to limit the risk of damage from dismantling and transport and to avoid the logistical issues of transporting heavy metalwork. However, if hot works are required (as they are, for example, for extensive repairs to leadwork), the risk to the site may sometimes make *ex-situ* treatment a better choice. Other types of treatment may simply be difficult to carry out on site, such as repairing failed aluminium frames or structures that require special welding techniques to create joins that will not succumb to corrosion. Metal statuary may require lifting and removal if structural or internal corrosion issues are to be properly addressed.

On the other hand, the decision to work off site should never be undertaken simply for convenience or to avoid the problems of setting up a worksite compliant with health-and-safety regulations.

The best approach will need to be evaluated case by case, and will depend on the type of metal, the nature of the damage, and the type and extent of repair required. For instance, cast iron is prone to fracture, so transport should be avoided if possible. The decision will affect the choice of materials and techniques for repair and repainting: for instance, slow-drying lead paints would not be suitable to apply *in situ*, and if wrought ironwork must be repaired on site, traditional forge welding would not be possible.

Historically, ironwork was often pre-assembled off site, dismantled for transportation, then reassembled on site, which means that many traditional fixings can be released without loss or damage (with the exception of rivets, joints secured by lead or by caulking, or any components fixed securely into masonry). In theory this should make dismantling straightforward, but in practice it is rarely true. Taking the example of railings, it would first be necessary to assess the impact of dismantling the stone (or brick) plinths or copings into which the rails are fixed, typically caulked with lead. Even where the caulking is failing, removing the railings will usually cause severe damage to the plinth, which itself may be of historic significance – as well as difficult or even impossible to replicate. Even with components considered relatively easy to release, such as window casements, dismantling and refitting will stress the frame and the glass, and is also likely to damage the surrounding timberwork or masonry and the wall finishes.

Inigo Jones's gateway, Chiswick House – cathodic protection provided an alternative to the destructive removal of corroding cramps from the fragile stonework.
Bill Martin © English Heritage

For statuary made of non-ferrous metals, it is important to assess the severity of the existing damage, its location, size and weight, before deciding whether removal would cause more damage to the sculpture or its plinth than working *in situ*.

Given that *in-situ* conservation is generally best for metalwork, what methods are most suitable? Cathodic protection (in which the metal is turned into a cathode, and thus protected through an external supply of electrons) can be used to halt the corrosion of embedded iron components, with minimal disruption to the surrounding materials. Repair techniques include cold methods involving pins, bolts or rivets, stitches, plates and fastenings. Two-pack epoxy adhesives can be used to make small non-structural repairs (such as gap-filling) on ferrous metals, and fibre-reinforced epoxies – sometimes paired with other techniques such as stitching or welding – can be used to strengthen structural castings. Components may also be reinforced or repaired using filaments of carbon or

Small losses or dents in ferrous metals can be conserved and recoated as is, or filled with epoxy-based proprietary materials or using brazing materials and techniques. Decorative elements can be preserved instead of cut and replaced.
Bill Martin © English Heritage

glass, bonded with polymer resin on to a well-cleaned surface. If the risk assessment allows hot works, repairs can also be made by welding, brazing, and soldering.

An additional advantage to all these methods is that they encourage minimum intervention and maximum retention of original materials, as well as allowing the repair to remain easily identifiable – considerations that are of course central to best-practice conservation. The *Metals* volume in the English Heritage *Practical Building Conservation* series looks in more detail at this isssue.

Heritage crime – a material threat

Diana Evans, *Head of Places of Worship Advice, English Heritage*
Mark Harrison, *National Policing and Crime Advisor, English Heritage*

A tiny minority of the population considers the significance of historic materials to be in their value on the second-hand market. That might mean stealing furniture, metal plaques or swords for a niche market. Often it means theft of metal flashings from a low roof to sell to an unregistered scrap metal dealer, but increasingly it means organised crime targeting irreplaceable stone, copper and lead. In 2011 19% of all listed buildings, and no fewer than 38% of listed churches, were attacked by criminals damaging materials. Overall, 14% of listed and unlisted places of worship suffered from metal theft.

The very positive response of many police forces is now bearing fruit. Where the theft of historic lead and copper is being taken as seriously as that of telecoms, power or railway cables, effective detection is happening. In Lincolnshire, where rural parish churches have been targeted repeatedly at huge cost to the morale and finances of their communities, six men have been accused of 22 such thefts. Diligent policing combined with the expertise of the Crown Prosecution Service, which now boasts 14 heritage crime specialists, means that metal theft in Lincolnshire has been dramatically reduced. In Durham a 75% reduction in metal theft has been achieved by concentrated policing.

English Heritage has been working very closely with police forces, the Association of Chief Police Officers and local authorities, congregations and community groups to communicate this positive message. Where prosecutions are in hand English Heritage is actively involved in preparing Impact Statements to demonstrate to the court that these crimes are not 'victimless'; on the contrary, the removal of lead and subsequent water ingress cause serious damage to underlying historic materials. Such statements give those who care for heritage a voice that can influence sentencing. Those convicted are less likely to 'get away with it' as many people felt they did in the past.

But there is no room for complacency. The cost of metal on commodity markets may have temporarily stabilised but will inevitably rise again. Police resources, currently focused on metal theft, will be reallocated. English Heritage is therefore working with partners to test better methods of fixing metals, of marking and securing them, so that theft is more difficult and ownership more obvious. The next edition of *Conservation Bulletin* will provide more information about these new developments. English Heritage is committed to keeping traditional materials and skills in use; our focus is on alternative ways to achieve this, not on letting criminals' personal greed destroy our national inheritance.

Ledlok being installed on an aisle roof in rural Norfolk following a theft. The roof is still safely in place and on another secluded church near by, which had also had Ledlok applied, thieves abandoned their attempts to steal the lead.
Chris Wood © English Heritage

Protection of archaeological sites through monitoring and design

John Stewart
Building Conservation & Research, English Heritage

The protection of vulnerable features on archaeological sites with cover buildings is a long, but essentially *ad hoc* tradition. Some structures, often quite simple, have fortuitously conferred protection. Others have not. This is because of a lack of understanding of the processes of deterioration affecting such sites, and the kind of environment required to conserve them.

Recently there has been an effort to better understand archaeological sites and, in turn, the most appropriate design parameters for their cover buildings. In England, this approach was first applied in 2004 to the replacement structure for Brading Roman Villa on the Isle of Wight (design by Rainey Petrie Johns for the Oglander Roman Trust). This was in response to flooding of mosaics in 1994, followed by condition assessment and environmental monitoring.

Chedworth Roman Villa in Gloucestershire had been protected with vernacular structures since *c* 1867. In 1995 intensive environmental monitoring and condition assessment were used to define appropriate long-term conservation strategies. A decision was subsequently made to erect a replacement structure, completed earlier this year (design by Feilden Clegg Bradley Studios for the National Trust).

Both new structures use a combination of materials and design to create the most stable internal environment possible, largely by passive means. At Brading the temperature is stabilised through good insulation (including a sedum roof) and ventilation controlled by window louvres. At Chedworth, natural ventilation is supplemented by a mechanical system only when conditions demand it; there is no artificial cooling. Conservation heating controls relative humidity and prevents condensation. Both structures exclude direct sunlight shining on to the mosaics. Eight years on, the Brading mosaics remain in stable condition; the mosaics under the newer building at Chedworth will be monitored, but hopefully with similarly positive results.

These examples involved the replacement of existing structures. An entirely new cover building is being considered for the magnificent 13th-century tile pavement at Cleeve Abbey, Somerset. This was excavated in 1876, then reburied. Since it was acquired by the State in 1951 it has been exposed to the elements for eight months of the year for public benefit. As a result, these significant tiles have suffered accelerated loss. In 2006 English Heritage began intensive diagnostic monitoring of the pavement and its environment within a temporary marquee. Since then, the marquee, with various modifications, has significantly reduced deterioration of the pavement, with the result that specific environmental parameters can now be incorporated into the design for any new cover building.

These examples illustrate how an understanding of complex sites through scientific assessment can be successfully applied to architectural design. There are, however, other environmental parameters that remain difficult, or impossible, to capture precisely with current technologies. Designs for new cover buildings therefore need to be sufficiently flexible to allow for modification of the internal environment as required.

The Frater pavement at Cleeve Abbey protected under a temporary marquee. Its properties of ventilation and insulation were modified during the monitoring period.
Sophie Godfraind © English Heritage

Castle Drogo

Peter Inskip

Peter Inskip and Peter Jenkins Architects

Castle Drogo was designed by (Sir) Edwin Lutyens in 1910 and its construction on a promontory overlooking Dartmoor continued until 1930. The house is essentially of one material: granite. Granite also extended as paving over the mastic asphalt roofing, transforming the complex roof terraces into a wonderful *promenade architecturale.* In addition to the roofing, asphalt was used within the walls and parapets as a vertical damp-proof membrane that was often continuous with the roofing asphalt. From the 1930s, the paving stones had to be lifted regularly to track down and patch defects in the asphalt below, and by the 1960s the complete paving, so important to Lutyens's design, had been permanently removed to allow easier access for roofing repairs.

Drogo was acquired by the National Trust in 1974. Between 1983 and 1989, new asphalt was laid across all of the roof planes and the parapets around the whole of the perimeter were dismantled and rebuilt to enable a lead damp-proof course to be introduced. Although these repairs appeared to be successful, signs of failure began to reappear over the next few years. In the light of this, the Trust decided to carry out holding repairs and commission a comprehensive investigation. We were commissioned as consultant architects in 1994 and, working closely with English Heritage, on-site testing started in 1996.

As inspections progressed it became clear that water ingress still posed a significant threat throughout the castle. It was recommended that detailed investigations be carried out to identify the mechanisms causing the problems so that strategic, long-term and sustainable solutions could be determined. To this end, studies of Lutyens's drawings, the building archive and the physical fabric revealed the materials and construction methods that had been used both in the original as well as the successive attempts at repair.

Castle Drogo, Devon: the application of 21st-century technical solutions has at last allowed the persistently leaking roof terrace to be restored to Lutyens's original design.
© Chris Goddard

Roofing

With the roofing, it could be seen that the original build-up was technically deficient and the subsequent repair solutions over the years were ineffective. Asphalt was a comparatively modern material, but the problems of a 'cold roof' were not known at the time and the roofing was designed without insulation or ventilation. Not only was there no provision for accommodating thermal movement at abutments with concrete, steel and granite, but successive campaigns of repair had severed the continuity with the vertical damp-proof membrane and water was entrained below the roofing and into the fabric.

It was, therefore, decided to employ modern roofing technology and a strategy was developed with the specialist manufacturer Bauder for the design of the waterproofing membrane, insulation and ballast to ensure performance and longevity of the construction and to minimise maintenance requirements. This was used in conjunction with Ruberoid cloaks and damp-proof courses. This provided an inverted 'warm roof' to eliminate the interstitial as well as the surface condensation that affected so many of the bedrooms immediately below the roof. The choice of the membrane was determined by its resistance to differential movement, that of the insulation above the membrane by its ability to resist interstitial condensation damage and cold bridging problems. Reinstatement of the granite paving not only prevents wind uplift of the insulation, but recovers a key element of Lutyens's design. The new damp-proof courses also allowed the removal of the recent lead version, by then already corroding and failing, and this dramatically improved the Castle's appearance, returning it to Lutyens's design of sheer uninterrupted planes of granite.

Pointing mortars

For the stonework, Lutyens had used an early cement-based mortar with considerable similarities to hydraulic lime mortars. However, he used granite aggregate and, because of this, his mortars have proved to be unstable with little resistance to water ingress. These had been replaced with new pointing in the 1980s using a Portland cement mortar with a waterproofing additive; it failed due to shrinkage relatively quickly, and a thermographic radar survey of the elevations revealed how water had built up within the masonry and how the mortars were hindering the evaporation of moisture through the jointing. The 'free lime' precipitate that had so disfigured the elevations was a direct result of water escaping when it eventually found a route.

Both the existing mortars and possible replacements were monitored in a series of trials on the elevation to help determine which was the most appropriate. The stonework was cleaned and the trial mortars were matched to the colour and texture of the original. The cement pointing of the area of wall that was being monitored was raked out and re-pointed with two different hydraulic lime binders of varying mixes, totalling four different combinations. Electronic probes were inserted into the pointing to form a grid of sensors wired to a data logger, from which information was downloaded every six weeks. The data logger was also linked to a weather station that simultaneously recorded the specific weather conditions. Monitoring over 18 months indicated that the hydraulic lime mortars were reducing the moisture levels within the wall dramatically and that lime staining was also being arrested. This led to the selection of the appropriate repair mortar.

Once a strategy had been determined, the chapel was repaired in 2006 as the first phase. A three-year monitoring period then ensured that the repair strategy was successful, allowing for any adjustments to be made before proceeding to the next phase. The clear aesthetic improvement in the presentation of the chapel, with the building cleaned, paving reinstated and lead flashings removed, demonstrates that a technical and scientific response to the building's failings can be coupled with a return to the original design and the recovery of a great work of art. The repairs are now being extended to the remaining sections of the castle, following the rigorous analysis and testing of materials and methodologies to arrive at a sustainable repair strategy.

Castle Drogo: trials of existing and different hydraulic lime mortar mixes within the west elevation.
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Safeguarding the Future

These are challenging times for our historic buildings – but with the right knowledge and skills we can still give them a bright future.

Many challenges lie ahead for building conservation. Climate change, EU legislation and the economy will all continue to be constraints, but may also bring benefits. Sustainable development is now a major aim of government policy and sustainability is the very stuff of building conservation.

Climate change may not cause significant harm to traditional buildings, but some of the proposed mitigation measures may (Pender pp 37–8). Increasing regulation often results in favourite treatments being banned, but as Fairchild and Henry show (pp 44–5), it is also the chance to test more benign alternatives.

A scarcity of craft skills and materials is a problem that afflicts building conservation the world over (Odgers pp 42–3), but closer to home it is being tackled in significant ways (Houghton and Willett pp 40–1; Henry pp 43–4). English Heritage's new National Heritage Protection Plan (Sloane pp 35–6) has also proposed action plans to redress many of these problems. None is more pressing, however, than the need to maintain an adequate number of conservation officers (O'Reilly pp 38–9) – the front-line troops in our battle to secure England's historic buildings a constructive future.

The context for future action: The National Heritage Protection Plan

Barney Sloane

Head of Strategic Planning and Management Division, English Heritage

The National Heritage Protection Plan (NHPP) was launched by the Rt Hon John Penrose MP, Minister for Tourism and Heritage, on 23 May 2011. Its aim is quite simple, if very ambitious – to improve our shared ability to protect the best of our nation's historic environment. It is coordinated by English Heritage but effectively owned by the heritage sector. Devised in consultation with numerous bodies across the sector, the NHPP has two key principles – one, that there are a number of important priorities for action which are understood and shared by the majority of the heritage sector and the public; and two, that it is important not only to understand what makes up our heritage but also to comprehend the nature of impacts upon it. From these flows the potential to develop concrete and coherent action plans right across the sector and thus to iron out duplication, identify gaps in coverage and build real collaboration.

The NHPP integrates research priorities with the necessary transformation of that research into practical actions and outcomes. It is therefore divided into eight Measures (see table p 36) which between them help to structure the nature of this relationship and avoid the artificial distinction between research and investigation on the one hand and practical management and conservation on the other. To provide thematic focus to this effort and to establish a clearer framework for collaboration, these Measures encompass a number of different prioritised Activities, all derived from the consultation at the heart of the Plan. A full list of the Activities can be seen on the NHPP pages of the English Heritage website (**www.english-heritage.org.uk/NHPP**).

It is these Activities that provide the common framework of priorities within which it is possible to develop Action Plans, comprising projects or programmes of work set out to achieve particular, defined protection results. In developing their Action Plans different organisations, communities and individuals are able to play to their own strengths and objectives – the common language of priorities empowering people to identify potential to collaborate or share approaches.

English Heritage has its own firmly established Action Plan published online and it will be this, informed by regular consultation on the Plan, which will set our own course for advancing our research on issues such as building materials. Currently our work in this area falls into a number of different but related Activities all within Measure 2. The first relates to our work to reduce attrition of building materials. This set of projects falls within the wider Activity to address Attritional Environmental Threats (Activity 2C1), and includes our work on soft wall capping (see Viles pp 27–8), limestone decay (see Pinchin pp 12–15) and traditional paint. The conservation of traditional buildings and ruins depends on cost-effective methods of slowing decay, and our expertise here is important.

The second main objective is to ensure sustainable sources of traditional building materials (Activity 2D5, Materials Supply Loss). The local distinctiveness and character of our built environment is at serious risk of erosion if traditional materials such as stone and thatch cannot be sourced for repair or redevelopment. Work with CLG on the Strategic Stone Study (see McAlester pp 24–5) has provided us with a good evidence base for potential building stone sources, and we are turning now towards ensuring that robust, traditional and affordable thatching alternatives will be available for the future (see Letch pp 28–9). The objective with each of these programmes is to assess the threat and develop realistic responses that can be implemented by owners and planners; the approach is one of developing collaboration with academic and commercial partners.

The priorities for action under these two Activities did not emerge fully formed from nowhere – they developed as a response to urgent and sustained need on the part of owners and to intelligence gathered about the scale of the problem and changes in technology. The NHPP aims both to assist in promoting this information exchange and to bring organisations together on shared goals. Both the NHPP structure and the English Heritage Action Plan form the basis of consultations each year (December and January), but we encourage constructive views and comments at any time through the dedicated email address: **NHPP@english-heritage.org.uk**.

A summary of the Measures making up the framework of the Plan. These are not methodological distinctions but are focused on the outcomes – the protection results we want to achieve.

NAME	SUMMARY
Measure 1 Foresight	Long-range assessments of likely trends, scenarios and models of change which might affect the historic environment.
Measure 2 Threat assessment & response	Short-range assessment of threats (and opportunities) to the historic environment arising from known impacts, and developing responses.
Measure 3 Identification & recognition	Survey identifying previously unknown historic assets which may be worthy of protection.
Measure 4 Assessment of character & significance	Development of clear understanding of the character and value of historic assets and places to inform protection and management strategies.
Measure 5 Protection of significance	Development and maintenance of formal protection systems including national and local designation, historic environment records and other management toolkits.
Measure 6 Managing change in the historic environment	Decision-making activity (such as through the planning system) in response to proposed change to heritage assets or places.
Measure 7 Protecting & managing major historic estates	Coordinated activity by major (eg multiple site) estate owners to ensure the upkeep and protection of that estate and its contents.
Measure 8 Advice, investment & grant aid to owners	Delivery of practical advice, investment incentives, and/or grant aid to property owners to reduce risk to heritage assets.

Possible impacts of climate change on building conservation

Robyn PenderBuilding
Building Conservation & Research, English Heritage

Many decades of preserving buildings have led conservators to some comfortable conclusions: most are intrinsically robust, and if a building of some antiquity is still standing, it is probably fit for purpose and well suited to its environment. The spectre of climate change calls such beliefs into question. Buildings could be faced with conditions for which they were not designed, and which they have never before encountered.

The current scenarios for the UK suggest that temperatures will increase significantly, especially in cities; that patterns of rainfall and soil moisture will alter; and – still more worryingly – that there will be greater instability and storminess. For buildings constructed using traditional methods and materials, the impacts of this seem likely to be small: systems such as timber framing and mass walls of masonry were developed over thousands of years, and have proved able to withstand most conditions. For modern construction, which is based on innovative materials and systems such as curtain walling, long-term viability is rather more uncertain.

One risk common to all buildings is the likely increase in run-off flooding, especially in cities, where the ground is often sealed with cement and tarmac. Another general concern is the potential for warmer climates to support introduced timber pests. Native insects cannot attack wood unless it has first been broken down by moisture-loving fungi, so the classic remedy for pests such as deathwatch beetle has been to find and remove the sources of water. Unfortunately, some exotic pests (such as the Asian longhorn beetle, *Anoplophora glabripennis*) can attack healthy, dry timber, suggesting trouble ahead for both forestry and buildings in the UK. The *Timber* volume in the *Practical Building Conservation* series has more information about current and potential new pest species.

However, the greatest risk arising from climate change is not the altered weather, but rather ill-considered attempts at mitigation. Construction and occupation of buildings are major sources of carbon emissions, with energy use skyrocketing since the end of the Second World War. As incomes increased and energy became cheaper, expectations of 'basic' comfort became ever higher; occupants now wish interiors to be warmer in winter, cooler in summer and all rooms to be conditioned to the same degree. Plumbing, artificial lighting, and central heating are all recent additions that quickly became necessities; offices and factories depend increasingly on air conditioning. Meanwhile, the production of high-energy materials such as concrete, metal, glass and plastic is a major source of greenhouse gases, especially since they are often transported across the globe from point of manufacture.

Despite the high carbon costs of new building construction and occupation, the UK government's regulations have concentrated on the fabric of existing buildings, particularly houses. Much is made of the need to increase the thermal mass of the envelope, but there has been little research on either the natural performance of traditional buildings, or the long-term impact of interventions on both performance and durability. To obtain a net benefit, the carbon reductions of energy-saving interventions must significantly outweigh the carbon costs, but this can be difficult to calculate, and in consequence is usually ignored.

In future, economic conditions are likely to be as unstable as the climate; but this too has been scarcely considered. Faced with these uncertainties, the safest approach must be to concentrate on

Traditional methods of construction, evolved over thousands of years, have the capacity to withstand a wide range of climatic conditions.

Anoplophora glabripennis – an exotic timber-eating pest that spells trouble ahead for England's historic buildings.
Wikimedia: University of Illinois/James Appleby

How modern buildings, based on innovative materials and systems, will respond to changing weather patterns is uncertain. © *Clive Murgatroyd*

no-regrets actions – such as good maintenance – rather than on risky and carbon-costly interventions. More research is needed to understand not only how buildings function in mechanical terms, but also how they are used, and how this affects energy consumption. Exact figures for whole-life costs may not be needed: for good decision-making, it may be sufficient to look quite broadly at the likely carbon impact of various options.

Vernacular architecture can provide good models of sustainable construction and occupation. The future looks more challenging for modern buildings, and conservators may sometimes be faced with an uncomfortable choice: either to make radical changes, or to record and abandon.

English Heritage and other bodies dedicated to understanding the behaviour of real buildings over the long term have a vital role to play, identifying and supporting best practice, and ensuring that regulations are always in the best interest of sustainability rather than short-term commercial gain. The *Building Environment* volume of the English Heritage *Practical Building Conservation* series, which will be published next spring, looks in detail at energy efficiency.

Integrating significance and fabric in local authority policy

Seán O'Reilly
Director, Institute of Historic Building Conservation

There is a surprising – and unfortunate – disjunction between development, as the fundamental agent of change today, and how we manage our existing places, the all-inclusive 'historic environment'. That disconnection disguises the pivotal role local authority conservation services play in promoting standards in the proper care of the fabric of buildings and is a challenge that the Institute of Historic Building Conservation (IHBC) has been working hard to address.

That disconnection feeds a damaging misconception that conservation services are exclusively concerned with a small world of *listed* building. Although much of a conservation service's time may be occupied with designated fabric, its officers also set *de facto* standards for proportionate care across all our historic buildings and places.

The role of conservation services in development management also includes a wider duty to care for historic places as a sustainable resource. Shaping local planning policy, enforcement, development control and heritage advice are just some of the conservation operations that set a standard recognisable to applicants, neighbourhoods and communities.

In that context, it is equally important to recognise that a building's needs for proper physical care and conservation are not tied to its designated status. The huge stock of familiar, traditional ('pre-1919') buildings demands the same repair and maintenance as the finest historic fabric.

England's planning policy, the National Planning Policy Framework, specifies that decisions about conservation must recognise that fabric embodies value: 'Significance', it says, 'derives not only from a heritage asset's physical presence, but also from its setting'. 'Character' and 'preservation', the operative words in statutory duties, also require that proper account is taken of fabric.

Because caring for fabric is a sensible starting point for managing significance, building materials remain a primary consideration for local planning authorities. Properly done, this allows conservation services not only to promote appropriate building materials but also to create market opportunities for relevant businesses.

But how can conservation services make a difference: stretched beyond capacity; often misunderstood, even by otherwise informed colleagues;

Rye, East Sussex: protecting the patina of England's historic places depends on the expert advice of appropriately resourced local authority conservation services.
© Fiona Newton

frequently disregarded; and invariably undervalued for the multi-disciplinary skills they must wield, and the benefits they secure?

The services can specify and work towards appropriate and sustainable procurement procedures. As well as advising on how – indeed if – new materials and practices can fit with the old, they can also assess actual standards of work, and even secure enforcement. More widely, through shaping development plan policies, advising on asset management, providing guidance to customers and colleagues, addressing market failure, and influencing new design, they can make a real difference on the ground.

However, given the scale of the construction sector, and the challenges the historic environment faces, conservation services cannot achieve the necessary level of impact on their own. Partnering is the key, and the trade and professional bodies that they engage are essential to securing wider success.

The IHBC, for example, is working with its partners to tighten links between accrediting and trade bodies so that the base line of skills for practitioners can be improved. Enhanced standards in conservation training will strengthen conservation services. A new national occupational standard in conservation, tied to conservation standards in the IHBC and the RIBA and underpinned by international guidance from ICOMOS, is helping to shape a more integrated framework of skills and advice for the future, and we look forward to English Heritage playing an increasingly substantial role in adopting such standards.

Work on updating the British Standard in Conservation, BS7913, is also progressing. Widening the range of standards and specifications in this way can provide the foundations for more effective integration between local authorities and the development industry. Such changes are implicit in evolving conservation practice: IHBC membership is now divided equally between public and private sector. They are also fully in line with the recommendations of the most business-minded of policy thinking, not least the so-called 'Penfold Review' into 'non-planning' consents, sponsored by the Department for Business, Innovation and Skills.

The 'win' is where the adviser in the local authority can rely on the standards of the applicant's agents, professionals and tradesmen – and vice versa. Local authorities need to keep on doing what they have always done and make full use of all the policy tools available to them to care for places. But now that our sector's focus has extended from the detailed scrutiny of the cautiously controlled, to include all-encompassing concepts of 'historic environment management' and 'sustainable development', it is all the more important that planning policy leads the way in managing significance by caring properly for fabric.

Work-based training in traditional building skills

Karen Houghton, *National Manager, Building Traditional Skills Scheme* and Clara Willett, *Manager (2006–12), Traditional Building Skills Bursary Scheme*

With 25% of the building stock constructed before 1919, the sheer number and range of traditionally built structures in the UK is vast. The shortage of people with the appropriate conservation knowledge and craft skills to work on these buildings is therefore a critical issue.

Since 2006, Cadw, ConstructionSkills, English Heritage, the National Heritage Training Group and the National Trust have joined forces to do something about it. Pooling resources and using Heritage Lottery Fund grants they have worked together to facilitate work-based training opportunities for traditional building craft skills. Two projects – the Traditional Building Skills Bursary Scheme (TBSBS) and the Building Traditional Skills Scheme (BTSS) – aim to facilitate innovative, flexible and accessible training opportunities to help reduce the skills gap in the built heritage sector.

In six years the TBSBS has facilitated and funded 136 placements: training opportunities of quality rather quantity. The BTSS will initially offer 60 work-based training placements, and then approximately another 260 training courses or other opportunities. Here we evaluate the TBSBS, now in its sixth year and outline the adaptations and aspirations of the BTSS as it begins.

With nationwide coverage (TBSBS includes England and Wales) these projects work in partnership with a broad range of companies and organisations to offer work-based training placements. A contractor acts as a host for a trainee, who learns as they work alongside experienced craftspeople. The projects have successfully operated with small and medium-sized companies and particularly effectively with sole traders, where a constant relationship can develop between trainer and trainee.

The projects aim to be inclusive – there is no upper age limit – and also encourage women and ethnic minorities, who are under-represented in the current workforce. The training placements are as flexible as possible. Trainees can undertake their placement full or part time or in blocks, and use part of their bursary for formal courses. Trainees need no formal qualifications, but some relevant experience is required and enthusiasm and motivation to learn and work in the sector are essential.

There have been challenges. Some building crafts, such as traditional roofing and fibrous plastering, have failed to attract either host or trainee; indicative perhaps of the craft's recognition that some prior conservation knowledge or practice is relevant or that specific training applies. But as word spreads of the training opportunities on offer and about the added value of enhancing skill sets, this will hopefully change.

Through BTSS, Aimee Henderson has embarked on a 12-month Conservation Project Manager placement. Based on the Transform Manchester project at the Manchester Town Hall and Library and under the guidance and support of Richard Baister, head of the host company Heritage Project Management, Aimee is thriving. Richard says of Aimee: '[her] previous experience has already given her an excellent grounding in conservation, and her working knowledge of heritage issues and practices is proving invaluable'. Aimee aims to achieve her NVQ Level 3 in Construction Site Conservation through her bursary placement and says: 'This is such an exciting project to work on, partly because of its scale and ambition but also partly because of the new challenges it's presenting me with. I know I'll leave the placement feeling far more confident as well as more professionally equipped for the real world.'

In terms of encouraging a more diverse workforce, the TBSBS has improved on the industry statistic of 2% women working in hands-on construction by granting 15% of its placements to women. However, it has failed to attract or recruit significant numbers of ethnic minorities. The BTSS is therefore mounting a more pro-active and focused marketing campaign at regional level, and is aiming to provide 15% of its bursaries to women and 5% to people from minority ethnic backgrounds.

To date 44% of trainees have gained their Level 3 National Vocational Diploma in Heritage Skills. By also successfully completing a health and safety test, individuals are eligible for the Heritage Skills Construction Skills Certification Scheme (CSCS) card. Notwithstanding formal qualifications, the benefits of the project are evident to both trainee and business: 78% of trainees continued working in the built heritage sector, and 80% of placement hosts felt it had benefited them.

The Heritage Lottery Fund has agreed to fund the TBSBS for a further three years. This will enable it to target displaced apprentices who as a result of the current economic climate have lost their hosts. BTSS has now been operating for four months, and aims to build upon the successes of the TBSBS. Over the next three years, this project will also offer a much broader range and greater number of training opportunities. These will include supported work-based placements up to master-craft status, as well as a series of short introductory and taster courses to encourage new entrants to the field of building heritage. Consequently, the project will also support a broader range of accreditation and vocational qualifications – from heritage craft skills through to site project management.

BTSS is being delivered through a regional network of coordinators, which allows the project to work closely with local companies and projects. This will prove particularly welcome in this difficult economic climate when new training opportunities are scarce. Certainly 98% of hosts from the TBSBS want to host another placement.

This winning formula of strategic agencies working in partnership with local companies and organisations is producing valuable and beneficial results for all concerned. The combined resources and efforts of national organisations working together with private sector companies and charities have built a strong network that is set to expand and strengthen. At the centre of this are the keen and motivated individuals who bring real dedication to learning and developing new skills that will stand them in good stead for a future career. This is welcome news for our precious built heritage.

Simon Doyle undertook a 12-month placement with TBSBS, followed by training with the National Heritage Ironwork Group bursary scheme. He has now set up a company with a fellow ex-NHIG trainee as heritage blacksmiths, amalgamating the traditional skills with conservation sensitivity. 'My work-based training exposed me to realistic situations and dilemmas that needed practical solutions. During this time, I not only honed my blacksmithing skills, but I learnt to deal with historic metalwork with a conservation approach, adapting my techniques as necessary.' Simon has already achieved the NHIG Award for Blacksmithing Conservation and plans to attain the Institute of Conservation's Professional Accreditation of Conservator-Restorers (PACR) very soon.

Training – a universal challenge

David Odgers
Odgers Conservation Consultants

The understanding of materials has always been a fundamental aspect of good building conservation. This understanding must be based on explaining theoretical principles and backed up by establishing good practical techniques. This is the challenge of teaching the Building Conservation Masterclasses at West Dean College, where a combination of lectures and practical work on the ruinettes and training walls (which were relocated and rebuilt when English Heritage's Fort Brockhurst Training Centre was closed) is used to develop the skills of students, almost all of whom are from the UK or Ireland.

But how do these challenges change if conservation professionals from all over the world are assembled, such as for the biennial ICCROM/Getty Stone Conservation course held in Rome? The simple answer is, surprisingly little; although there are different materials involved (ranging from coral buildings in Tanzania to archaeological sites in China), the underlying causes of decay and the principles behind any proposed conservation repair have much in common. However, time and again, the students, while embracing the knowledge that is being imparted, will highlight the availability of suitable materials and the training of local contractors in their use as their most significant challenges.

Nowhere were these issues more evident than in recent trips to Palestine. Contractors working on projects in the Old City of Jerusalem – while having to overcome considerable logistical difficulties in getting to their work – often had no access to lime, and any that was available (hydrated lime) often had to be smuggled into the city. Although it was still possible to explain the theoretical principles of using lime, practical demonstrations had to be devised to suit the materials that were available. In the last two years, there has been better access to hydraulic lime although this has generally not yet become available in the Occupied Territories. A training course for conservation professionals in Nablus revealed that old lime kilns in the hills above the town were still being used and, from necessity, the workers were using lime putty and locally sourced brick dust. The training, carried out under the direction of the Welfare Association, has helped to enable Palestinians to take some responsibility and pride in the conservation of their historic structures.

There is nothing more satisfactory than seeing the benefits of training making a real difference in the way in which a community views its historic buildings. After contributing to an ICCROM training course in Sharjah (UAE) in 2009, it became clear that the existing repair of a rapidly diminishing stock of historic structures was being carried out using highly inappropriate materials – a mix of cement and gypsum. After a number of visits, and with the active support of the Architect to the Ruler and the Ruler (Sheikh Sultan bin Mohammed Al-Qasimi) himself, a complete change of approach was adopted. Within a few weeks of approval, three large lime pits had been constructed, lime putty was being slaked and transferred to bins for ageing, bricks were crushed and mortar trials carried out.

Sharjah – the problems of using cement and gypsum in a dry but humid environment.

Apart from completely changing the materials being used, it was also necessary to train craftsmen to use them; fortunately most of the craftsmen were from the Indian sub-continent where lime is part of their heritage. Colin Burns (formerly with English Heritage) and I went to Sharjah in October 2011 and spent a very hot few days working with 12 craftsmen to hone their skills. Despite language barriers they were the most receptive group imaginable; their abilities to carry out rendering and mortar consolidation of walls and their diligence in looking after the mortars in very challenging environmental conditions were and continue to be exceptional. They also have a gift of manufacturing tools suitable for any job from a very basic stock of raw materials.

In the UK, we are fortunate to have a comparatively good supply of most of the materials that we

Nablus – pointing training in progress.
© David Odgers

associate with building conservation (eg stone, lime, timber, brick) – even if the variety available is much less than it used to be. The problem we share with many other countries is that we do not have sufficiently trained teams of craftsmen; our challenge in the future must be, as it always has been, to ensure training keeps abreast of any technical and material development.

Mineral safeguarding: securing the supply of building and roofing stone

Alison Henry
Building Conservation & Research, English Heritage

The process of sourcing stone for conservation and new build in sensitive areas has been discussed elsewhere in this issue (see Lott pp 5–7). Legal and planning issues aside, there are, in fact, numerous potential sources of historically significant building stones. While some historic quarries were abandoned because they were worked out, others ceased production in the face of competition from cheaper alternatives (such as bricks, concrete blocks, reconstituted stone and foreign imports) even though many retain significant reserves of winnable stone.

Modern extraction techniques may make it possible to exploit some of these previously uneconomic sources of stone. However, many other former quarries and hitherto un-worked deposits are likely to remain unexploited because they are either too close to other forms of development, have been used for landfill, have inadequate access, or have been designated as protected wildlife habitats.

In order to maintain supplies of traditional building stone it is important to protect their sources from development that could prevent their future exploitation. This can be achieved through a process known as 'mineral safeguarding', which recognises that such materials can only be extracted where they naturally occur, whereas most other forms of development can be more flexible about their location. The aim of mineral safeguarding is to ensure that these finite resources are considered as part of the overall development control process, so that the opportunity to win stone in the future is not compromised by planning decisions made today.

The National Planning Policy Framework requires local planning authorities to 'define Minerals Safeguarding Areas (MSAs) and adopt appropriate policies in order that known locations of specific minerals resources of local and national importance are not needlessly sterilised by non-mineral development'. Defining MSAs for sources of building stone requires detailed information on the nature and location of such deposits. The data collected by the Strategic Stone Study make a major contribution to this knowledge base (see McAlester, pp 24–5) by allowing both the location and extent of stone sources requiring safeguarding to be determined. In some cases, the MSA may need to be larger than the surface outcrop of the rock in order to create a buffer that protects it from being sterilised by incompatible development in the vicinity. For example, if housing development

The nave roof of Pitchford Church in Shropshire (Grade I listed) is covered in Harnage stone slates. At the time of re-roofing in 1999, there were no sources of suitable new Harnage slates. Planning permission was obtained to extend a former small local quarry to enable extraction of sufficient stone for re-roofing the nave, plus a small surplus for future patch repair. The protection of such potential sources of building stone, even though they may not be needed now, is vital in order to help maintain the character of thousands of historic buildings and areas in the future.
Chris Wood © English Heritage

were permitted immediately adjacent to a potential quarry, there would almost certainly be vigorous objection from residents to any subsequent application for stone extraction, whereas objection might be less if the nearest houses and access roads were several hundred metres away.

Once potential MSAs have been identified, the Mineral Planning Authority should consult with industry and others, including English Heritage and the British Geological Survey. Once they have been defined, the extent of MSAs must be shown in the Mineral Planning Authority's Development Plan Documents (DPDs) and supporting development management policies should set out the criteria against which applications for development in a MSA will be considered. For example, permission for incompatible development may be granted provided that all the stone is extracted and stockpiled prior to it taking place – although specialist advice would be required regarding the effect of storage on the quality of the stone.

Anyone with an interest in maintaining supplies of indigenous building stones is urged to take part in these consultations, and particularly those with specialist knowledge, such as county geology groups, conservation officers, architects and contractors. This will help to ensure that all potential sources of important building stones have been identified and that the policies to protect them are sufficiently robust.

Defining a mineral safeguarding area does not convey a presumption in favour of planning permission being granted for future extraction of the stone, nor does it preclude other types of development on or near the land; it simply flags up the presence of an important resource in order to ensure that it is properly considered in all planning decisions. However, this is a vital step towards ensuring a supply of indigenous building stones – essential for the conservation of the built heritage – for the benefit of current and future generations.

Red tape: is there a silver lining?

Jamie Fairchild, *Restorative Techniques* and
Alison Henry, *Building Conservation & Research, English Heritage*

In addition to challenges posed by climate change and shortages of traditional materials and skills, buildings conservation faces an increasing burden of regulatory control. A significant area of regulation relates to health and/or environmental concerns associated with the manufacture and application of materials used in conservation work.

A raft of requirements and restrictions has been introduced under REACH (Registration, Evaluation, Authorisation and restriction of Chemicals), a European Union regulation that came into force in 2007. The Regulation aims to protect human health and the environment from the harmful effects of chemicals, by improving information about their hazards and, where necessary, banning or restricting their use. Manufacturers of chemicals (including certain traditional materials such as lime putty and paints) must register their products, and anyone using chemicals in their business must check that they are doing so in accordance with the manufacturer's safety advice.

Recently, the use of Dichloromethane (DCM – the active ingredient in the most widely used paint and varnish strippers) by professionals and DIY users has been banned under REACH, although it is possible that a derogation allowing use by properly trained professionals may be taken up later this year. Another casualty is paint based on white lead. The last UK manufacturer of white lead decided that the cost of compliance with REACH made production prohibitively expensive. Consequently, two UK producers of traditional lead-based paint have ceased manufacture, and a third is considering importing white lead from China; it remains to be seen what the cost implications will be.

It sometimes seems that restrictions are put in place to deal with the 'lowest common denominator', and that sensible practitioners end up suffering because of the actions of careless cowboys. For example, if those using DCM had always worn appropriate protective equipment, would there have been the same imperative to ban its use on health grounds? Possibly not. But once a restriction is in place everyone has to face the challenge of adapting their working practice to accommodate the new demands. Inevitably this results in increased cost that has in the end to be passed on to the consumers. This might be because alternative materials are either more expensive to buy or take longer to work, or because a practitioner, accustomed to using a particular material for a particular job, has to undertake trials to find the most suitable alternative material. However, restricting the use of certain products may also bring conservation benefits beyond reductions in risks to people's health. It can provide the stimulus to develop new materials or adopt new practices that may, in fact, be better than those they replace.

The decline in the use of sand blasting for cleaning buildings enabled more appropriate cleaning technologies, such as super-heated water, to become more competitive, and their use has increased in the last 15 years
Alison Henry © English Heritage

In the case of sandblasting, for example, silica sand is an aggressive and indiscriminate abrasive, rarely appropriate for cleaning sensitive historic surfaces, but it was widely used because it was cheap and abundant. Because of the health risk of inhaling silica dust, its use was increasingly restricted from the 1950s onwards. Alternative abrasives, such as calcium silicate or crushed marble, were significantly more expensive, so an immediate effect of the restriction was to drive up the price of abrasive cleaning. But by removing silica from the range of options available, the more expensive abrasives suddenly became competitive, and choices began to be based more on the technical merits of particular products and less on their relative cost. So, although the cost of abrasive cleaning increased, there has undoubtedly been a compensating reduction in damage to historic building fabric. Furthermore, the increased cost of abrasive cleaning meant that other cleaning technologies became more competitive, and this was one factor contributing to the development of super-heated water for building cleaning.

With the decline in the availability of DCM, paint and varnish removers have become more selective and it may be necessary to use different products to remove different paint layers. Trials are usually necessary to determine the appropriate materials to be used for removing multiple paint layers.
A;ison Henry © English Heritage

Similarly, DCM is much cheaper to produce than alternative paint-stripping chemicals. It works rapidly and indiscriminately, acting on a variety of coating types and removing multiple layers quickly. These properties propelled it to the forefront of the DIY paint-removal market and it was also widely used by professionals. However, apart from the health risk of inhaling DCM vapours, any rinsing water had to be treated as special waste (although in many cases this requirement was ignored), which added to the cost of using it correctly. Furthermore, when removing coatings from a porous substrate such as stone or plaster, there is a risk that paint residue may be carried below the surface, leading to staining. The banning of DCM has forced practitioners to look at alternative methods. Certain coatings, such as bitumen-based paints, waxes and some acrylic-based paints, can be removed effectively using super-heated water or steam without any risk of migration of the soiling, and without generating waste that requires special treatment, to the benefit of both the building and the environment.

The need to find an alternative active ingredient in paint strippers, encouraged by the market demand for so-called 'eco' strippers, has driven research by manufacturers. Many new products are more selective than DCM, and are only effective on particular paint types. If the aim is to remove multiple paint layers as quickly as possible, then clearly this is a disadvantage, but if there is a need to remove only some of the layers – where historic paint has been over-painted with inappropriate modern paint for example – then this selectivity can be a distinct advantage. Using a selective stripper, it is possible to remove, say, an acrylic coating, with very little damage to underlying oil-bound lead-based paint, enabling re-decoration with the appropriate paint without loss of the historic paint layers or the risks associated with removing and disposing of lead paint.

So, while increased regulation can be costly and inconvenient, there are occasional positive benefits for conservation. It is clear that restrictions are unlikely to decrease in the future, so if industry can continue to respond through innovation and development of improved products and techniques, there might just turn out to be a silver lining to some of that red tape. ■

News from English Heritage

Research on the value of conservation areas

Research by the London School of Economics has found that people value living in conservation areas. Commissioned by English Heritage, this is the first rigorous, large-scale statistical analysis of the effects of conservation areas on house prices in England. This analysis was based on data from more than 1 million property transactions between 1995 and 2010 from the Nationwide building society, and information on the characteristics of more than 8,000 English conservation areas. The report also drew up an assessment of people's perceptions of conservation areas, and how these relate to house prices, based on a survey of residents in 10 conservation areas in and around London, supplemented by interviews with local planning officers.

Among the results the analysis showed that properties in conservation areas had higher prices and greater price appreciation, even after adjusting for location and other factors that affect prices. Properties closer to the centre of conservation areas had the highest prices in this study, suggesting that people value being surrounded by a greater density of heritage. Meanwhile the residents' survey suggested that overall there was no universal negative attitude toward planning regulations, with those who had applied for such permissions having more positive attitudes to them than those who had not. The study also found that the more distinctive and attractive residents perceived an area to be, the higher the property premiums were found to be in that area.

The full report is available to download from our website – **http://www.english-heritage.org.uk/professional/research/social-and-economic-research/value-conservation-areas**

Contact: john.davies@english-heritage.org.uk

Local authority historic environment specialists

Data produced by English Heritage with the Association of Local Government Archaeological Officers (ALGAO) and the Institute of Historic Building Conservation (IHBC) continue to show a fall in the number of historic environment specialists providing advice to local authorities in England. At the beginning of 2012 there were 909 full-time equivalent (FTE) historic environment specialists providing advice. This comprises 568 FTEs working on building and area conservation and 342 FTEs providing archaeological advice (numbers may not sum consistently as a result of rounding).

These figures represent a continuation of a downward trend that began in 2006, a trend that has seen numbers fall by more than 25% in overall historic environment advice. This breaks down into a drop of 16% in archaeological advice, and a drop of 31% in conservation advice.

In the past 12 months the number of archaeological specialists advising local authorities in England has fallen by 3%, while the number of conservation specialists has fallen by 6%.

Contact: owain.lloyd-james@english-heritage.org.uk

European Heritage Heads Forum

The 2012 European Heritage Heads Forum (EHHF) meeting took place in Potsdam and Berlin from 23 to 25 May. EHHF is a professional and expert network for national heritage heads that provides a forum for information and experience exchange. Under the title 'Public Engagement with Cultural Heritage', the meeting considered the joint role of active citizenship and governmental responsibility in the preservation of our cultural heritage and the need to arouse public interest in the preservation of monuments, particularly among young people. The meeting critically examined the role the EHHF can adopt in order to protect Europe's cultural heritage now and in the future.

Conclusions, further information and papers from the meeting can be found on the EHHF website – **http://www.ehhf.eu/.**

Contact: christopher.young@english-heritage.org.uk

New Work in Historic Places of Worship

This document is a revision and extension of the 2003 publication, aimed at all those responsible for formulating proposals and making decisions about historic places of worship. It sets out the principles that English Heritage applies when considering proposals for the alteration or extension of such buildings, including new illustrations and sections on flooring, energy efficiency, renewable energy generation and introducing works of art. It will be amended following the publication of the National Planning Policy Framework, to ensure that it is as up to date as possible, and then made available

in hard copy as well as pdf format. It can be downloaded from
http://www.english-heritage.org.uk/publications/new-work-in-historic-places-of-worship
If you cannot access it on line contact Customer Services Department. Telephone: 0870 333 1181
Fax: 01793 414926 Textphone: 0800 015 0516
Diana.Evans@english-heritage.org.uk

National Heritage Protection Plan

English Heritage is committed to encouraging and empowering as wide a diversity of people as possible to care for the historic environment. To ensure that our work under the NHPP takes this into account, we have carried out an Equality Impact Assessment and identified the key actions we will take. This includes consulting with experts on under-represented heritages and identifying thematic terms which English Heritage can use to make our digital records more accessible to researchers interested in the history of women, disabled people, lesbian, gay, bisexual and transgender people, minority ethnic groups and minority faith groups.

The Impact Assessment is published on our website at **http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/other-nhpp-docs/**. If you have comments or further suggestions to improve the Equality Impact Assessment, please contact
nhpp@english-heritage.org.uk
Rachel.Hasted@english-heritage.org.uk

Regulatory reform

As part of its drive to promote growth, the government is now using the Enterprise and Regulatory Reform Bill to progress a series of legal reforms which will:

- reduce regulation by combining Conservation Area Consent and Planning Permission;
- increase clarity over what is or is not listed by making it easier to apply for Certificates of Immunity from Listing and allowing list descriptions to specify parts of a building or its curtilage which are not of special interest;
- reduce the need for consent by enabling owners to enter into Heritage Partnership Agreements which can legally grant consent in advance for certain minor or repetitive works.

Further reforms to simplify listed building consents have been consulted on over the summer and the government's plan to take them forward will be published in the autumn.

Contact: sarah.buckingham@english-heritage.org.uk

West Dean College

Between January and May 2013, West Dean College will be offering the following courses in its English Heritage-validated Building Conservation Masterclasses programme:

14–16 January Practice and Theory: Managing Change in Historic Buildings
4–7 February Conservation and Repair of Architectural and Structural Metalwork
4–7 March Stone Surfaces and Detail
25–28 March Specifying Conservation Works
22–25 April Conservation and Repair of Brick, Terracotta and Flint
7–10 May Conservation and Repair of Masonry Ruins
13–16 May Managing Wildlife on Historic Monuments
28–31 May Conservation and Repair of Plasters and Renders

(10% discount to English Heritage employees)

For more information please contact the CPD Coordinator at West Dean College,
tel: 01243 818219 or e-mail:
cpd@westdean.org.uk
website: **www.westdean.org.uk/college** and click on CPD

Archives and Collections

News and Events

The Aerofilms Collection goes online

In June the Britain from Above website was launched. With an initial 16,000 images available, the site gives free access for the first time to thousands of historic aerial photos of Britain from the Aerofilms Collection. In the first week after the launch **www.britainfromabove.org.uk** had received 237,677 unique visitors and 3,147,148 page views.

Users have quickly taken to the website and are spending an average of 30 minutes online, contributing more than 22,000 comments and tags to the images as well as assisting with locating images that have left the Cataloguing Team stumped. Our most prolific community member has made just short of 4,000 comments and tags on images throughout the site, as well as spending time offline trying to find out where some of the unlocated images were taken.

The website allows users to create special interest groups – 116 of them so far, ranging from people with an interest in their local areas to more thematic groups discussing lakes, distilleries and even golf courses!

Saving glass negatives

In 2009 the English Heritage Archive began a project to conserve, catalogue and digitise the nationally important Bedford Lemere collection of 23,000 architectural photographs dating from the late 19th century.

During conservation, we found that the thin gelatine emulsion layer, which carries the image, had become detached, blistered or peeled away from the glass base of some of the negatives. Using scanning electron microphotography and other specialist tools, English Heritage Archive conservators and staff from the Archaeological Science teams discovered that on damaged negatives there was a change in the composition of the surface, probably caused by a failure to properly wash away processing chemicals. The result was a weaker bond between the glass and the emulsion layer and, over time, the blistering and peeling of the emulsion.

Armed with this knowledge our conservators have been able to develop a more effective approach to stabilising these important images, which is now being published by the British Museum.

English Heritage's museum collections arrive on-line

During November 2012 our collections of museum objects will start to appear on the English Heritage website. In the first phase the Wernher Collection of decorative arts at Ranger's House and the archaeological and architectural collections from Rievaulx Abbey will be made available with a selection of items from the Architectural Study Collection.

Digital cataloguing of the collections started in the 1970s under the Department of the Environment. The early computer databases have been replaced with a modern sophisticated collections management system, but much of the content dates back to the 1970s, 1980s and 1990s.

In addition to object records the on-line system will include records for related people (such as artists and collectors), publication references, exhibitions and sites. It will be possible to discover more about the collections through Theme and Period pages.

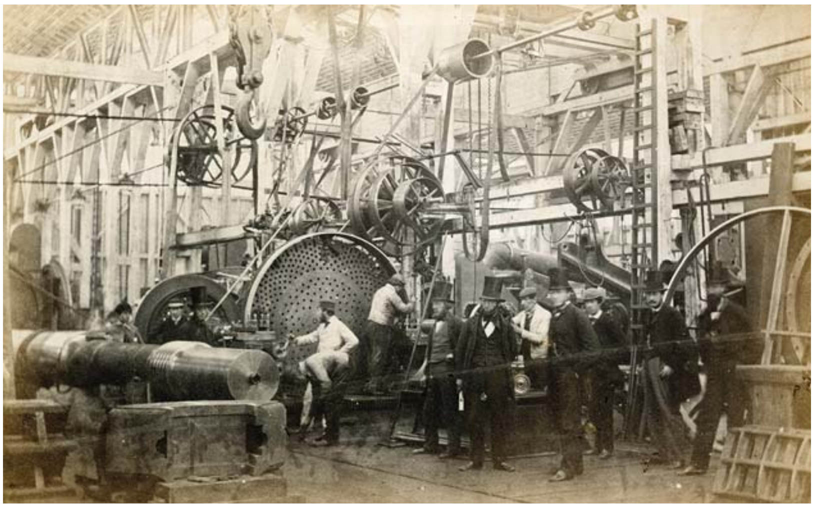
A glass negative with a peeling emulsion layer.

New Accessions to the English Heritage Archive

Notable recent acquisitions include the purchase of two photographically illustrated books that show different aspects of industrial archaeology. The first, published in 1863, contains some of the earliest visual records of industrial interiors in Britain. In *Dockyard Economy and Naval Power*, the author Patrick Barry illustrated his concerns about British naval readiness by commissioning 31 unique photographs of the interiors of factories, mostly in London close to the Thames. (Archive ref: Patrick Barry: PXB02)

The second book is in effect the first photographic record of underground mining: tin miners are strikingly posed at work in Dolcoath and other mines in Cornwall through Woodburytype prints taken by John Charles Burrow in 1893: *Mongst Mines and Miners* celebrates his ability to take high-quality images in previously impossible hot and dusty conditions. (Archive ref: J C Burrow: AQ/12/032)

Our knowledge of Victorian railway structures is enhanced by the acquisition of original records of the Euston Arch made by Bruce Allan Ormerod, who was the British Railways engineer in charge of this famous demolition of 1961–2: these meticulous measured drawings include coloured isometric records of the structure made during the process of removal. English Heritage is grateful to Brian J Ormerod for this donation. (Archive ref: B A Ormerod: AQ/12/028)



View of 1862 or 1863 showing Messrs Penn and Sons' engine works at Greenwich. This company employed more than 1500 workers under the direction of John Penn FRS (born 1805 in Greenwich). This pre-eminent firm was the major supplier of marine engines to the Royal Navy including those of HMS *Warrior*, the first sea-going steam warship in the world, launched near by on the Thames in 1860.

Services and on-line resources

The English Heritage Archive collections comprise around 12 million items relating to England's historic environment, 70% of which are photographs dating from the 1850s to the present day, as well as reports, drawings, and plans.

To find out more go to:
www.english-heritage.org.uk/archive
or contact: Archive Services, The English Heritage Archive, The Engine House, Fire Fly Avenue, Swindon SN2 2EH
tel: 01793 414600, fax: 01793 414606 or email: archive@english-heritage.org.uk

English Heritage Archives
www.englishheritagearchives.org.uk
The Archive Catalogue includes descriptions of more than 1 million photographs and documents

Portico
www.english-heritage.org.uk/portico
In-depth histories of English Heritage sites

Heritage Gateway
www.heritagegateway.org.uk
National and local records for England's historic sites and buildings

PastScape
www.pastscape.org.uk
England's archaeological and architectural heritage

Heritage Explorer
www.heritageexplorer.org.uk
Images for learning, resources for teachers

The following ***Designated Datasets*** held by English Heritage are available for download via the English Heritage website, **www.english-heritage.org.uk**. The data are suitable for use in a Geographic Information System:

- Listed buildings
- Scheduled monuments
- Registered parks and gardens
- Registered battlefields
- World Heritage Sites
- Protected wreck sites

Legal Developments

Planning cases under the National Planning Policy Framework

Mike Harlow, *Legal Director, English Heritage*

In the seven months that have passed since the NPPF was published I've seen dozens of planning inspector decisions and a few by the Secretary of State.

What I've been anxiously looking for is a sense that the weight to be given to heritage concerns remains broadly as it was. What I've been hoping for is clarity in the expression of the conservation objective, now that it is woven into the definition of sustainable development.

While I'm never personally going to agree with each decision, none have caused eyebrow vertigo. The scales used by the inspectors to weigh up competing concerns appear to be obeying familiar laws. What has noticeably changed, though, is the high-level reasoning.

One of the first cases concerned a site on Bunhill Row in the City of London. The London Borough of Islington refused a proposal to build 121 residential units up to seven storeys high next to a Grade I registered graveyard with lots of listed tombs in it. The applicant appealed. The impact on the setting of the designated heritage assets was the key to the case.

The inspector made all the right use of the NPPF policies, assessing: the significance of the heritage assets; the contribution of the setting to that significance; the impact on the significance; the public benefits from the proposal; and the necessity of the harm in order to deliver those benefits. Finally, she weighed up the harm against the public benefits that necessitated it.

Although there were public benefits that would 'make a considerable contribution to society', she came out in favour of conserving the important aspects of the setting and refused the application.

What was most heartening was her pin-sharp expression of the purpose of planning decisions. 'One of the core planning principles in the Framework is to conserve heritage assets … so they can be enjoyed for their contribution to the quality of life of this and future generations', she said. 'The assets in this case are of exceptionally high historic and architectural interest, influencing the character and distinctiveness of the area and as such are of very high value to the public.' 'As there would be a legacy of harm, I conclude that the appeal scheme would not constitute sustainable development.'

Another appeal decision that caught my eye concerned a proposal to build a house on vacant land in a conservation area in Leyburn, North Yorkshire. The significance of the area derives from a largely intact purpose-built workhouse complex.

The decision is forensic in its assessment of the way in which the proposed design of the new home responds to its context. Ultimately, the inspector concludes that the architecture is not entirely successful and that therefore it would cause 'less than substantial harm' to the conservation area. The new building would make a 'modest contribution to the national stock of energy-efficient dwellings', but that was not sufficient to outweigh the harm caused.

Without seeing the new design in context it is difficult to tell if this is a remarkable decision or not, but again what stands out is the expression of the principles that lie behind the reasoning. The inspector concludes: 'There is no dispute that the [new] building would be sustainably located, or any question over its commendable achievement of the high [energy] performance standards . . . However, the Framework's positive support for sustainable development is tempered by the need to conserve heritage assets. Design which would harm a heritage asset cannot be seen as truly sustainable.'

It is perhaps a slightly confusing paragraph as the inspector's first use of 'sustainable development' is limited in meaning to energy and physical resources conservation, but he does then emphasise the true and broad definition of sustainability as encompassing design that conserves or enhances the historic environment. It is almost as if he is consciously making the journey to the holistic view of sustainability. Maybe in a year's time the NPPF definition of sustainability will have completed its transition from left to right brain and will become second-nature.

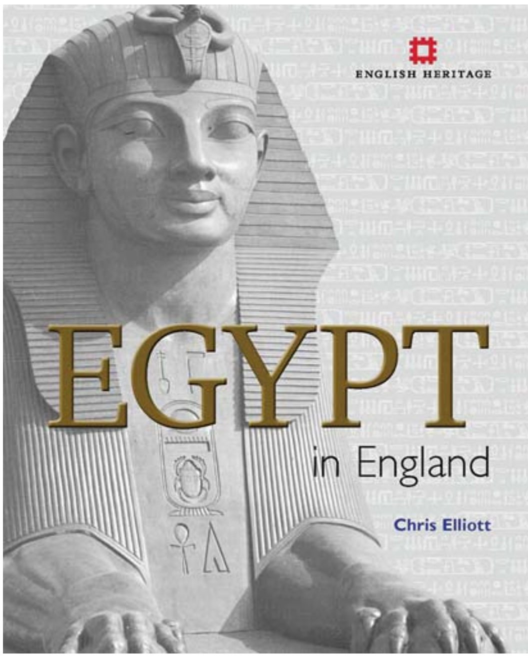
So, helped perhaps by the fact that the NPPF is a single short document covering all national planning concerns, it appears as though decision-makers have readily grasped that anything that unjustifiably harms heritage assets or fails to take opportunities available for improving the character of an area is not sustainable development. The NPPF will not support it and neither would an NPPF-compliant local plan.

If you want the latest thinking on this and other heritage protection issues, then visit our new Guide to Heritage Protection in England (**http://www.english-heritage.org.uk/professional/advice/ hpg**). It is a continuously updated textbook on the law, policy and guidance that protects and affects England's heritage.

We hope to add a searchable planning and court case database in the coming months, but in the meantime we will post new and interesting decisions on Twitter: @EHLegalDirector.

New Publications from English Heritage

Egypt in England
Chris Elliott



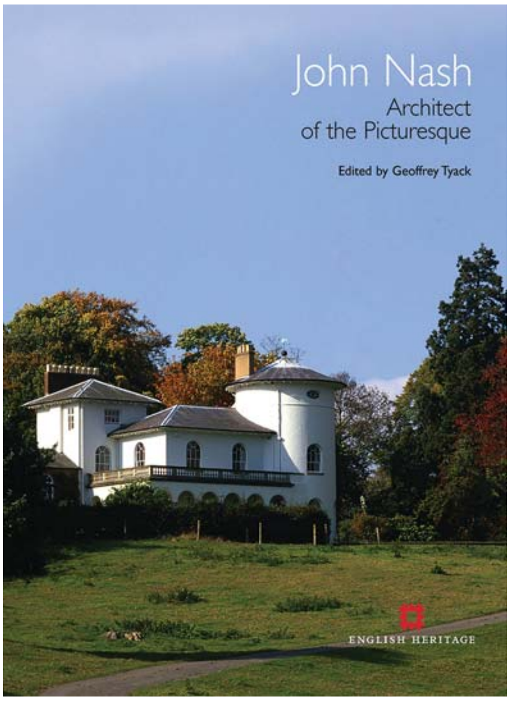
For more than 200 years the exotic Egyptian style in architecture has been a sign of our fascination with a civilisation that has had a long-lasting and deep-seated influence on British culture. From its fashionable success in the Regency period to its varied uses in the 20th century, Egyptian-style architecture has much to say about what ancient Egypt represents to us.

Egypt in England is the first detailed guide to the use of the Egyptian style in architecture and interiors in England. Fully illustrated, it combines a series of topic essays with a guide, which allows sites to be located and explains what can still be seen. A variety of buildings and monuments – from cinema, supermarket, synagogue and factory, to folly, mill, Masonic temple and mausoleum – are highlighted in the book. For those who do not know their architrave from their entablature, or their Anubis from their Uraeus, there are also glossaries of architectural terms and ancient Egyptian deities.

This engaging book is an accessible and practical guide for a general audience, but has enough depth to be useful to scholars in a range of subject areas.

PUBLICATION DATE: November 2012
PRICE: £ 25.00
ISBN: 978 1 84802 088 7
Paperback, 336 pp; 240 illus

John Nash: Architect of the Picturesque
Edited by Geoffrey Tyack



As the man responsible for the creation of Regent Street and Regent's Park, John Nash left an indelible mark on the West End of London, and his two most famous buildings – the Brighton Pavilion and Buckingham Palace – are crucial to any understanding of the monarchy in the age of the Prince Regent. Yet, even before he became involved in these ambitious projects, he made a major contribution to domestic architecture through the design of a series of stylistically varied villas, country houses and cottages in which he applied the doctrines of the Picturesque with an inventiveness that has rarely been surpassed.

Scholarship since the publication of Sir John Summerson's *The Life and Work of John Nash, Architect* has cast new light on several important aspects of Nash's work. The aim of this book – which originated in a symposium held by the Georgian Group in September 2009 – is to bring together this recent scholarship in a single volume, and so bring this most engaging of architects to a new generation of readers.

PUBLICATION DATE: December 2012
PRICE: £50.00
ISBN: 978 1 84802 102 0
Hardback, 264 pp; 90 illus

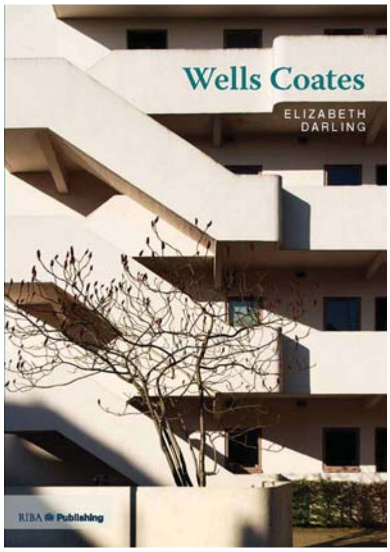
The Royal Engineers at Chatham 1750–2012
Peter Kendall

Chatham has been vitally important for the defence of the nation for more than four centuries. This superbly illustrated book, using previously unpublished archives, tells for the first time the story of the defences that protected the dockyard and the key route to London, from substantial lines of earthen ramparts and ditches to major citadels and innovative forts. Part of the narrative focuses on how the Medway area developed a major role in the storage of explosives and artillery, how the first training school for the Royal Engineers was founded at Chatham in 1812 and how the soldiers were trained in siege exercises.

The author gives the human side of the military training and conflicts, with his descriptions of the life endured by the new recruits and the terrible conditions in barracks that were gradually improved, particularly following on from the Crimean War.

PUBLICATION DATE: October 2012
PRICE: £50.00
ISBN: 978 1 84802 098 6
Hardback, 336 pp; 176 illus

Wells Coates
Elizabeth Darling



The architect-engineer Wells Wintemute Coates is recognised as one of those who brought about the introduction and development of architectural modernism in the UK. His work for Isokon was featured in the 1999 'Modern Britain' exhibition at the Design Museum, while, more recently, the restoration of Lawn Road and Embassy Court has brought his work to the attention of a new audience.

The primary concern of this new study is to re-introduce Coates to a modern audience through an account of his *oeuvre* and the context in which it was created. It shows how, as a designer of products, interiors and buildings, he developed a new formal and spatial language of design, which worked to influence the path of British modernism during the 1930s and after the Second World War.

PUBLICATION DATE: July 2012
PRICE: £20.00
ISBN: 978 1 85946 437 3
Paperback, 176 pp; 164 illus

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Please quote the appropriate ISBN and make all cheques payable in sterling to Orca Book Services. Publications may also be ordered from **www.english-heritageshop.org.uk** Prices and postage charges may differ on the website.

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