
I first became aware of Cowdray when reading the Chapel Plaster Consolidation case-study in the excellent English Heritage Technical Handbooks by John Ashurst in the late 1980s, and was therefore delighted to be asked to advise on the repair mortars for the major conservation and repair project at the 16th century Palace ruins. This was timely – the Practical Building Conservation Series is being revised and to be re-published (in ten volumes), but it also coincided with the sad passing of the hugely influential John Ashurst.

Cowdray, in Midhurst (West Sussex), constructed in the 1520s on the site of an earlier 13th century Manor House (Coudreye), is an exquisite early Tudor courtiers palace, frequently visited by Henry VIII. During refurbishment in 1793 a devastating fire largely destroyed the house and it has since remained a romantic ruin painted by both Turner and Constable. Repairs by St John Hope in 1909-14 – cement/lime blend pointing mortars, concrete lintels to door and window openings, and tile capping to exposed wall-heads - are credited with saving Cowdray from total collapse.

Mortar samples were collected from most areas of the original build and all known (with thanks to Oxford Archaeology Ltd) phases of alteration and repair. An unusual feature of the original Cowdray mortars (and plasters) is that these yellow clay/sand mortars had changed colour where they had been in close proximity to the fire in the
same way that yellow Raw Sienna pigment becomes red Burnt Sienna when heated. All tonal gradations of yellow through pink to dark red mortars were present in the mortars according to the intensity of, and proximity to, the heat and flames.

"Cowdray Ruins - Conserved fire-altered plaster and mortar"

The aim of the analysis of these samples was to establish the nature of the historic mortars used with a view to allowing closely matching mortars to be specified for the conservation works. Our analysis was able to clarify and confirm the various phases of repair and alteration. The St John Hope mortars were clearly identifiable as early Portland cement and lime blends. 17th century reductions in width of window openings were also clearly distinguishable, as the local riverbank was the sand source for these mortars. There is a useful archaeological purpose to mortar analysis – the recent study of the mortars of the Anne Boleyn Gatehouse at Hampton Court Palace was able to identify a slight difference between the 1520 Wolsey mortars and the Henry VIII mortars of 1540. The original Cowdray mortars were based on lime with slight but clearly detectable hydraulicity, the source being the chalk Downs of Surrey or Sussex. These limes were of high quality and were used extensively including for the construction of much of London prior to development of Portland cement in the early 19th century. The yellow ‘as-dug’ sand had been sourced locally from a pit now on the golf course on the Cowdray Estate and charcoal kiln-fuel was present in most samples.

The specification of repair mortars on a ‘like-for-like’ basis is valid, but caution must be exercised. It goes without saying that colour, texture, and visual characteristics of the existing should be carefully matched, but the selection of binder type depends on additional factors:

- Proper laboratory analysis of the existing must be undertaken in order to identify the binder type, mix proportions and if the binder is lime, to determine
the degree of any hydraulic properties. Without analysis, the specification of binder type on a like-for-like basis is little more than guesswork.

- An informed evaluation of the performance of the existing should be assessed, and
- other factors which may affect the selection of binder considered. There is little doubt that the interests of the particular building must be the primary concern, but factors such as the time of year the work is to take place may need to be taken into account.

At Cowdray, the original 1520s brickwork mortars had proved durable and performed well in all protected locations. The work was to proceed between March and November, and the conservation contractors, St Blaise Ltd, highly skilled with vast experience in the use of lime.

Limes are no longer produced from the Surrey/Sussex chalk, but Lincolnshire chalk is the raw material used in the production of Singleton Birch limes. The obvious binder selection on a 'like-for-like’ basis would be properly matured Chalk Lime Putty.

“Hampton Court Palace: Anne Boleyn Gateway, Clock Court Elevation - completed work”
This is the lime used for both the recent Tower of London - White Tower, and Anne Boleyn Gateway conservation projects, and indeed lime putty has been the binder used at Hampton Court Palace for all repair phases in Base Court, Master Carpenters Court, Chapel Court and Tiltyard Tower since the early 1990s.

It was however decided at Cowdray to use the weakly hydraulic Singleton Birch NHL2 for the pointing repair mortars to both ashlar and brick as many originally interior wall faces, no longer protected by a roof, lacked ‘normal’ exterior weathering details. St Astier NHL3.5 was used to match the St John Hope mortars to the more exposed crenelations, and St Astier NHL5 to re-bed the tile capping to wall-heads. The sand used in the original mortars, a deep yellow clay-rich sand was matched using the local Pendean ‘as-dug’ sand. As sands for hydraulic lime mortars should ideally be washed, this sand was sieved to remove much of the clay. Washing the sand would have removed all of the clay, and therefore much of the colour. It was decided that matching the red ‘fire-altered’ mortars was appropriate both aesthetically and historically (as the fire is a significant event in the buildings history), and for these mortars a red Devon sand was blended with the Pendean sand in varying proportions. The lime: sand ratio of 1:2, typical of the mortars analysed, was maintained and the repair mortars ranged from 1 part lime to 2 parts Pendean to 1 part lime to 2 parts Devon red and every permutation between. Charcoal particles were added, as were chalk nodules. Interestingly, in the fire-altered mortars, particles of incompletely mixed lime had not changed colour and these white particles, less obvious in the unaffected yellow mortars, had become a significant feature of the red mortars.
The selection of the visually correct blend of ingredients was entrusted to the site conservators led by Robin Gullon-Smith. Many of the tradespeople were employed locally and trained on the project. It was noticed that the colour of mortars at depth were often different to the surface colour, and the conservators respected this by matching the deeper mortars separately to the surface mortars. This is so that as the new mortars weather, the mortar colour ‘integrity’ would be maintained – this is advanced conservation!

The selection of the correct binder is a complex subject, and depends on experience of both success and failure. The simple rule I normally employ is to put the building first and choose the weakest binder that I believe will prove durable for the particular application and location. Proper analysis of existing materials is of great use in informing the specification and decision, but limited budgets preclude this research on many projects.

Great progress on the need to specify and use the appropriate binder has been made over the last twenty-five years, but there is still much room for improvement. There are both technical and aesthetic reasons to specify and use lime mortars, and neither is adequately considered on far too many projects. I am concerned that the stronger hydraulic limes are too often used in historic building repair. These limes are far stronger than all traditional limes prior to the development of Roman Cement in the 1780s which was used principally for external renders and mouldings. All meaningful analysis I’ve seen shows that there is an inverse relationship between hydraulicity and porosity and permeability (the more hydraulic; the less porous and less permeable), and hydraulic limes will continue to gain strength over time in exactly the same way that Portland cement does. I was dismayed last year when the pointing mortar specification for a major London conservation project was changed from putty to NHL3.5 because “that was what the builders normally used”. Problems associated with the use of too strong a lime are becoming apparent – it is always absolutely crucial that mortars are sacrificial to masonry - softer, more permeable, and more porous. Temporary hydraulic lime holding repair mortars to medieval statuary to the west front of Peterborough Cathedral were proud of the adjacent stone after five years and had set so hard that they had to be removed by mini-grinder.

A crucially important issue often overlooked or inadequately addressed is the ageing and weathering characteristics of mortars. Traditional soft mortars age gracefully – the mortar surface slowly weathers away and in this process aggregate, kiln-ash, and other particles are exposed – this is unlikely to occur with the stronger modern hydraulic lime mortars, especially when mixed with washed sands.

_Cowdray Ruins Conservation & Repair Project on behalf of The Cowdray Heritage Trust and Martin Ashley Architects._
Hampton Court – Anne Boleyn Gatehouse Conservation & Repair Project on behalf of Historic Royal Palaces and Martin Ashley Architects.

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