Session: (CS3.4) Session CS3.4: Optimizing Delivery of Repair Mortars

Balancing Principles with Practice in the Conservation of 375 year old Masonry Ruins

Speakers/Conférencier: Keith Blades – Principal, Keith Blades Consultant in the Conservation of Historic Buildings Incorporated

Session Chair: David Edgar

A National Historic Site, Sainte Marie Among the Hurons was a 17th Century French Jesuit Mission to the Huron [Wendat] nation, situated along the great trading route between Quebec City and the Canadian interior via the Great Lakes. The ruins of three original fireplaces dating to 1639 sit within the multi-layered 1960's reconstructed site and are part of a long-term conservation initiative.

First excavated in the 1940's the stonework has remained exposed for 75 years in a harsh environment. The introduction of dense cement pointing and capping nearly 30 years ago in an attempt to slow the rate of deterioration only served to exacerbate the condition of the stonework.

While the initial intent was to conserve the ruins with minimal intervention and maximum retention of original material, once work commenced it became clear that the stonework was in such fragile condition, much closer to collapse than was previously thought, that the approach had to be modified from stabilization in-situ, to taking down and rebuilding. Thus, the initial phases of the work concentrated on research, documentation and recording. This latter task involved the construction of mylar frames for the full sized tracing of the stonework in its as found condition.

A demountable bracing system was designed to permit careful deconstruction once the very hard and dense cement was removed. Rigid Styrofoam and bubble wrap were used between braced plywood sheets and the stonework to hold the assembly from collapse as the take down proceeded. Every stone removed from the wall was documented by individual reference that enabled the team to track the location and intervention on the stone.

The take down exercise presented fresh problems, as behind the dense cement facing, the core was simply powdered mortar. However, this condition revealed the broken tails of face stones resulting from the ongoing movement of the wall that could not accommodate the rigidity of the outer face set in cement and the core in lime mortar. In total over 300 stones were repaired using a reversible acrylic resin and stone dust mix.

The rebuild was carried out using hot lime mortars, gauged with small amounts of a pozzolan. The decision to use this mix was based on mortar analysis and the physical evidence of the surviving

mortars. The rebuild was completed by re-assembling the mylar frames and resetting stones to their exact original locations. Interpretation of the final appearance was based on careful comparison with the 1940's photographs and the physical evidence of mortars that were not original to the 1640's work. The issue of protection and interpretation of the stonework without compromising the visitor experience is an ongoing exercise.

Designing and evaluating repointing mortar mixes for highly exposed and damp historic buildings (church towers) in South-West England

Speaker Contact: Lucie Fusade – PhD Student, University of Oxford, School of Geography and the Environment

Session Chair: David Edgar

Many historic buildings of architectural significance, especially churches, are highly exposed to harmful environments, such as wind and driving rain. Moisture is one of the most common agents in the deterioration of building materials, leading to biological growth, salt damage, and dampness, that may have negative effects on the inside conditions. To ensure preservation of historic masonry, rain penetration needs to be mitigated. This is one of the main roles of mortar in the masonry joints. To cope with a specific environment, mortars can be tailor-made by choosing appropriate compatible materials to enhance some key properties. For example, a pointing mortar to deal with rain water ingress would ideally have a combination of high permeability to draw moisture out of the wall, and should be more porous than the surrounding stones, removing harmful soluble salts.

Looking at different traditional materials and compositions, this research aims to design and test a repair pointing mortar able to mitigate driving rain-induced moisture problems in historic buildings. This three-year project, in collaboration with practitioners from Historic England and the Churches Conservation Trust, combines laboratory experiments and test wall trials simulating driving-rain and natural evaporation, focusing on the South-West (SW) of England climatic environment.

In the first phase of the research, wood ash from a biomass boiler, a traditional hydroscopic material, was added in different concentrations (0%, 10%, 20%, 30%, 40%, 70%) as replacement of the aggregate by volume, in mixes using air lime putty and natural-hydraulic lime (NHL, 3.5 St Astier). Evaluation of water absorption by capillarity coefficient (WACC) (BS-EN 1925-2000), vapour permeability (BS-EN 1025-19-1999) and open porosity (BS-EN 1936-2006) were performed. It has determined that wood ash generally increases the open porosity and vapour permeability of lime mortars and from 20% added in a mix, slows down the WACC and the carbonation.

In the second phase, mixes were designed to evaluate the difference between siliceous and calcareous aggregates and binder rich mixes in the formation of the pore size and water absorption and drying property. Samples were exposed to wet curing conditions, similar in average to inland SW England in Summer: 15°C, 85% RH, and compared to laboratory curing conditions: 20°C, 40% RH. Selected mixes from both phases and using quicklime slaked with NHL were applied on granite test walls trials simulating driving-rain in SW England to determine whether the mortar joints help mitigate the ingress of rainfall.

Testing these mixes will improve the scientific understanding of the behaviour of the materials to inform the future design of repair mortars for damp buildings. It will also ensure that repair interventions, conducted by experienced masons using best practice methods, contribute to a sustainable preservation of historic masonry at risk.

Hot-mixed mortars in Scotland

Speakers/Conférencier: Roger Curtis, MRICS – Technical Research Manager | Conservation Directorate, Historic Environment Scotland

Session Chair: David Edgar

Lime mortars have been used in construction for thousands of years and continue to be used for the repair and maintenance of traditional buildings. Most lime mortars currently used in the UK are based on Natural Hydraulic Limes (NHLs) which are sold in bags as a dry hydrate powder. These products have only been commercially available relatively recently, but have been used on many traditional building projects in the past 30 years.

Prior to the introduction of dry hydrate powdered lime, lime mortars were prepared using either lime putty or quicklime mixes, the latter made as a 'hot-mix' with the lime and aggregate being slaked and mixed together in one operation. Evidence from historic texts suggest that hot-mixed mortars, sometimes including earth binders and other additives, constitute the majority of existing historic mortars. These traditional methods of preparing lime mortars can still be used in building and repair work today. Recent research by Historic Environment Scotland and others suggests that hot-mixed mortars were commonly used up until the 1950s and even later in many area and that they often perform better than modern dry hydrate mixes.

The use of hot mixed mortars seem to offer a number of benefits, including ease of preparing and working, a tenacious bond with the substrate, economy of materials, improved frost resistance, and an authentic appearance and finish. However there are a number of perceived and real barriers to the use of hot mixed mortars in building preservation projects today, namely a lack of understanding of the material and its preparation, a lack of skills and training, some issues with sourcing of materials and concerns about the consistency of the materials produced.

This paper considers the benefits and challenges of using hot-mixed mortars and reintroducing their use in Scotland and elsewhere. It considers a number of recent case studies where hot-mixed mortars have been successfully used in sometimes challenging conditions.

Case study 1: Sand Haa, Shetland - drying out a damp gable wall of a listed Georgian building in Shetland using traditional hot mixed mortars and locally sourced aggregate.

Case Study 2: Culross, Fife – using hot mixed mortars to reinstate traditional finishes to listed buildings in the conservation village of Culross.

Case Study 3: Crawfordjohn Church, Lanarkshire – replacing poorly performing natural hydraulic lime mortar with hot-mixed mortar to allow an exposed gable wall to dry out and improve clime change resilience.

The paper concludes by asking the question whether the reliance on the use of modern natural hydraulic dry hydrate lime mortars over the past 30 years has been the right approach, and suggests far from being 'complicated', hot-mixed mortars can in fact be successfully used in mainstream building preservation.

Improvements to Freeze-Thaw Resistance of Historic Mortars

Speakers/Conférencier: Michael Edison – President, Edison Coatings Inc.

Speakers/Conférencier: Chad Lausberg – Senior Chemical Engineer, Edison Coatings Inc.

Session Chair: David Edgar

While the long-term destructive potential of liquid water in masonry assemblies is well known, the potential for disruption of saturated mortars exposed to freezing conditions can represent a more challenging and more immediate problem. High permeability mortars, valued in historic preservation work, also have the potential to become rapidly saturated. Projecting elements such as buttress caps, water tables and copings are particularly vulnerable. The problem is exacerbated in situations such as pavements and stairways, where water ponding and saturation prior to freezing may be further complicated by the presence of deicing salts.

Early freeze thaw failures of air-entrained Type O portland cement-lime masonry mortar on projecting elements at the East Block on Parliament Hill in Ottawa led to initiation of a testing program aimed at evaluating a potential amendment for improving freeze-thaw resistance. Early freeze-thaw failures of several natural cement pavement mortars at the Foley Courthouse in Albany, NY led to a second study, examining a variety of historic mortars in pavement joints, including natural cement, natural hydraulic lime and portland cement-lime mortars.

The presentation reviews the testing programs and methods, the materials evaluated, the results of testing, and the mortar amendments determined to be most effective in improving freeze-thaw resistance while maintaining high moisture vapor permeability. Saturation coefficient reduction was

determined to be the most effective strategy for improving performance in salt-scaling resistance, as determined by ASTM C672 testing.