Session Track: Mortar and Masonry Construction
Session Code: CS02a

Paper: "Match the Mortar"....Is the Mason Contractor Qualified?

Presented by
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Speaker(s) Biography
Mario Machnicki is president of Marion Inc., a masonry contracting company based in Chicago. He is an engineer and has twenty-five years experience in the masonry restoration business. Mario has participated in traditional masonry training courses in Poland, England, Austria, France and Ireland.

John Speweik is the vice president of U.S. Heritage Group, Inc. He is an active member of ASTM C12, C7 committees and task group member of C12.03 - Specification Standard for Preservation Mortars. John is a mason, from a family of masons dating back to 1870 in Posen, Prussia.

Abstract
The understanding of what is meant by "match the mortar" defines the challenge. To the mason contractor this usually means color, to the trained preservation architect it means color and compatibility with surrounding masonry and overall performance. Matching mortar seems straightforward; however, even after detailed mortar analysis, property owners and architects still run the risk of a bad match. The work of matching mortar is delegated - architect to the masonry contractor on most jobs. The delegation continues down to the laborer – the mortar mixing guy, the starting position on most masonry crews, the lowest seniority position on the jobsite where the physical work of making the mortar happens. Measuring, counting, and mixing the ingredients of mortar i.e., cement, lime, sand and pigments consistently is key to his job security. The laborer is the one that hears it from the masons when the mortar boards go empty and he does his best work to keep them full. However; even his best efforts result in surprises unbeknownst to him. The sand for instance, has volumetrically changed due to the moisture content since delivery and pigments have experienced compaction due to vibration.

The repointing mock up samples have been approved on the mortar made from freshly delivered cement, lime and sand along with color pigments from behind the seat of the truck. The laborer does not know nor understand how these conditions will negatively impact his efforts to the mortar making process once the project starts. He also may not be aware that his very job may be at stake. These changes are not noticeable to most laborers or even highly experienced masons until the mortar is long placed and cured in the wall. But matching mortar is more than even this. After all the formulations, mixing and ingredient challenges are resolved it is usually the experience of the craftsman that plays the key role in final appearance.

The use of the right tool at the right time can make the difference between an approved mock up sample and one that is rejected. An experienced craftsmen will be able to judge the weather conditions and adjust his methods accordingly to consistently produce the most historically actuate joint profile.

Property owners and architects need to know that the requested mortar specifications are followed and produced to highest standard possible. A mason contractor's ability to identify individual mortar ingredient limitations such as hydrated lime volume loss, sand bulking and color pigment compaction can help to reduce the chances of surprises. A clear well-written mortar specification is a start but allowing the mason to mix individual ingredients at the site may come back to haunt the owner in the future. Is the mason contractor qualified to match your mortar?

This paper will discuss the variables of matching mortars from a mason's point of view. Emphasis will be placed upon obtainable options in eliminating mistakes at the construction site.

Session Track: Mortar and Masonry Construction
Session Code: CS02b

Paper: Science and Crafts – How Traditional Methods of Lime Mortar Making and Curing Control their Properties – Role of Water

Presented by
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Speaker(s) Biography
Ing.Michoinová Dagmar

Education and scientific degrees:
since 2000 - PhD theses, Civil engineer, Technical University Brno, Faculty of Chemistry, Study on historical techniques of making lime mortars and their influences on properties of lime mortar for the care and conservations of building heritage
1984-1990 - Degree in Technology of silicate chemistry, Institute of Chemical Technology in Prague, engineer of chemical technology

Foreign languages:
English, Italian, Russian

Employment:
1996 Technologist of conservation, in Technological Department of National Institute for the Care of Historical Monuments, Czech Republic

Main topics of interest:
research on conservation of historical lime renders and plasters, especially study of lime based materials and application of traditional but often half forgotten crafts and skills in conservation of architectural heritage, within the last 10 years principal investigator and co-investigator of 5 projects.

Publications:
1 books, 30 specialized articles, 1 utility patent, 2 scripts (co-author).

Prof. RNDr. Pavla Rovnaníková, CSc.

Education, pedagogical and scientific degrees:
2004 - Professor of Building Materials Engineering
1981 - CSc. (PhD) – Faculty of Civil Engineering, Brno University of Technology
1965-1970 (MA) - Faculty of Natural Science, Masaryk University in Brno

Foreign languages:
English, Russian

Employment:
1997 till now - Head of the Department of Chemistry, Faculty of Civil Engineering, Brno University of Technology
1970 till now - Department of Chemistry, Faculty of Civil Engineering, Brno University of Technology

Main topics of interest:
Chemistry and microstructure of silicate materials, corrosion of building materials, historical binders, within the last 15 years principal investigator and co-investigator of 19 projects.

Publications:
5 books, 280 specialized articles, 5 patents, 8 scripts.

Abstract
Increasing use of lime-based mortars for the maintenance of historic buildings and architectural heritage activates further research in these materials. Considering that the final properties of lime mortars are strongly influenced by the techniques of mortar making the study of traditional techniques of lime mortar making is an integral part of the research. The aim of this paper is to evaluate the role of water in traditional techniques of lime mortar making and curing (aftercare) on the carbonation evolution of lime binder and on physical and mechanical properties of mortar after 90 days.
The mortars prepared by different methods with aerial lime and with constant B/Ag ratio 1:3 by volume and diferent W/b ratios were tested. The influence of water/binder (w/b) ratio on lime mortar properties and the impact of curing conditions in the course of the first 90 days will be discussed.

Apart from the fact that decreasing w/b ratio decreases contraction after drying - which in practice means reduction of drying shrinkage - it also reduces porosity of mortar but at the same time it does not slow down the process of carbonation. A well set structure is obtained due to the use of stiff mortar with low w/b ratio and it results in increasing the mechanical properties of such lime mortar with low w/b ratio. On the contrary, increased w/b ratio has resulted decreasing mechanical properties and frost resistance as excess water has been prevented the development of a close bond between lime and siliceous aggregates.

Lime mortars test specimens (20x20x100 mm) were cured (aftercare) under different conditions. While one part of the specimens was not cured by moistening other part of the specimens was repeatedly moistened after it dried up. Repetitive moistening of dry lime mortar not only significantly accelerates the carbonation process but additionally, it strongly improves the quality of the cured mortar even after the process of carbonation was finished. A good interlocked structure of cured mortar has been obtained due to recrystallisation of calcium carbonate after repetitive moistening (30 cycles of curing) and it has resulted in an improvement of mechanical properties of mortar, especially of its flexural strength. In spite of porosity reduction due to repetitive moistening the increase of frost resistance of cured mortar has been obtained.

Following traditional recommendations of lime mortar making and the curing strongly improves the properties of such lime mortar. Benefits of some traditional techniques of making lime mortar were scientifically described. Acceptance of the results of this thesis would ameliorate conservation and maintenance of building heritage as it may improve the quality of mortar. In consequence it may support the prestige and importance of traditional crafts and materials.

Session Track: Mortar and Masonry Construction
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Paper: Adapting Existing Technologies to Understand Old World Traditions

Presented by
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Speaker(s) Biography
Dorothy Krotzer is Regional Director of Building Conservation Associates, Inc. (BCA) in Philadelphia, Pennsylvania. Before joining BCA, Dorothy had her own practice for 10 years and also worked as the senior architectural conservator at the Fairmount Park Historic Preservation Trust in Philadelphia. Dorothy has worked on a broad range of conservation projects throughout the United States. Her work typically includes materials testing, treatment planning and construction project monitoring, with an emphasis on architectural finishes and historic masonry structures. Recently completed projects include finishes analysis of the Lafayette Building in Washington, DC; creation of a conservation master plan for Randolph Hall at the College of Charleston, and interior masonry restoration of the Fairmount Water Works in Philadelphia. Dorothy has a BA in history from Hamilton College and a MS in Historic Preservation from the University of Pennsylvania. She is currently the chair emeritus of the Architecture Specialty Group of the American Institute for the Conservation of Historic & Artistic Works (AIC). Other professional affiliations include Association for Preservation Technology International (APTI), Association for Preservation Technology Delaware Valley Chapter (APT/DV), and Preservation Alliance for Greater Philadelphia.

John Walsh is Senior Petrographer/Geologist at Testwell Laboratories in Ossining, New York. John is a former NSF Graduate Research Fellow with a Masters Degree in Structural Geology from Columbia University. John's areas of expertise include the reverse engineering of existing materials and the investigation of failures related to material deficiencies and environmental exposure. He is the former Secretary of the Society of Concrete Petrographers and is active in various ASTM subcommittees. John is currently researching the petrography and chemistry of American-produced Rosendale cement.

John and Dorothy have collaborated on numerous historic mortar analyses at sites throughtout the U.S., including Belmont Mansion in Philadelphia, the College of Charleston in Charleston, South Carolina and the Montgomery Bus Station in Montgomery, Alabama.

Abstract
Modern methods of investigation are essential to our exploration of traditional craft and materials. By using readily available yet underutilized technologies, we can reveal crucial information about the provenance of traditional building materials. The application of these existing technologies and appropriate interpretation of the data they produce allow us to gain a better understanding of why materials were used, how they have endured, and how to best replicate them. One such technology is the use of petrographic and chemical analyses in the investigation of historic mortar materials.

Petrographic examination by a qualified petrographer/geologist, coupled with chemical analyses such as atomic absorption spectroscopy and x-ray diffraction (XRD), can yield an incredible amount of information about historic mortars and the people who used them. The utilization of these three specific

techniques can identify the way in which materials were harvested, how they were manufactured or prepared by craftspeople, as well as shifts in their availability throughout history. For instance, petrographic examination of lime microtexture helps the modern-day investigator understand whether the original lime used in a mortar was prepared as a putty or a hot-mix. This example illustrates the kinds of new insights into cultural building traditions that can be arrived at by applying these existing technologies. Such profound discoveries could never have been arrived at through the exclusive use of the more commonplace acid digestion technique for mortar analysis.

This type of in-depth analysis proved critical to developing an understanding of the history of material use for three historically significant buildings on the College of Charleston's campus. Perhaps even more importantly, the results of both the technical investigations and extensive historical reserach proved that the variety of mortar materials used at the College of Charleston represent a general trend in commercial availability of lime and cement products in the United States. Materials documented at the College of Charleston ranged from early-19th century, locally produced oyster shell-based lime to regionally-produced natural cement to early, prototypical Portland cement. This range of masonry materials clearly illustrates the evolution of product availability in the U.S. and how this impacted the ways in which buildings were designed and constructed in the 19th and 20th centuries.

This paper will discuss existing technologies that can be used to document historic masonry building materials, specifically petrography and chemical analysis through atomic absorption spectroscopy and x-ray diffraction (XRD), and what types of information can be gleaned from these techniques. We will also discuss the importance of a collaborative relationship between petrographer and architectural conservator to ensure the full amount of relevant information is provided to the analyst and that the findings are properly interpreted for the site and the client. Most importantly, this paper will discuss the breadth of information related to cultural traditions and building technology that these new technical applications offer. Discussion of a recently completed project at the College of Charleston will be included as a case study.