CS-08 Fired Clay Systems

Summary of Session CS08
These presentations focus on the treatment of masonry surfaces and systems and is not just limited to clay masonry. This session will present research on the use of limewashes – still popular in the UK but not used extensively in the US; research and use of lime-based grout for injection of voids in masonry walls; experimentation and sensitive treatment of Akoustolith tiles at Washington National Cathedral; and study and guidance on adapting flat arch terra cotta flooring systems.

Learning Objectives
1. Become familiarized with the historic use of lime washes and how they were utilized in the 19th Century.
2. Learn about the latest research in the area of treating masonry wall cavities.
3. Learn ways of sensitively conserving Akoustolith tiles, a fairly well used acoustic treatment material found in early 20th Century structures.
4. Understand flat arch terra cotta flooring systems, used extensively from the 1870s to the 1920s, and how they can be adapted to contemporary use.

CS08-1: Documentation and Testing of 19th Century Limewash Recipes in the United States
Sloane Taliaferro

1. Introduction
   a. Topic/Research goals: Understand the functionality of 19th century limewashes based on both testing and historic research
   b. Methodology:
      i. Documentation of historic recipes and references
      ii. ASTM testing of the historic recipes
   c. Limitations
2. Historic Recipes
   a. Purpose: To modify the properties of limewashes
   b. Sources: Journals, newspapers, letters, books, and builders’ guides were all sources of limewash recipes
   c. Ingredients: Discussion of the most commonly published limewash additives and the major functions
   d. Claims: The testing plan was designed to evaluate basic limewash properties so that the results could be compared to historic claims
3. Testing Plan
   a. Tests
      i. Discussion of tests (water-vapor transmission, adhesion, and chalking resistance)
      ii. Explanation of why those tests were chosen and how they related to historic claims
   b. Discussion of the recipes chosen to test and why
      i. Most commonly published limewash recipes
      ii. Recipes that used frequently published additives
4. Testing Results
   a. Adhesion (ASTM D3359)
   b. Chalking Resistance (ASTM D4214)
   c. Water-Vapor Transmission (ASTM E96)
5. Conclusion
   a. Discussion of trends in testing results for the different limewash recipes and how we can use this
   b. Recommendations for future research
CS08-2: Lime-pozzolan Formulations for Architectural Conservation
Irving Slavid, John Wathne, and Norman R. Weiss

1. Project began with the experimental development of a fluid, lime-based grout for the filling of cavities in historic masonry walls.
   a. The conservation literature is sparse on the subject, with relatively few useful details of research and evaluation.
   b. For non-hydraulic limes, the fundamental dilemma is, of course, that lime cures by carbonation, and cavities to be grouted are places where little or no air is available.

2. Focus has been on the use of pozzolanic admixtures, and in particular on metakaolin (dehydroxylated China clay).
   a. Metakaolin has a long history of use in the concrete industry for new construction.
   b. In the conservation community, however, there are only a handful of researchers who have worked with this material.

3. The gravity-feed grout was initially developed for structural stabilization of deformed walls placing the fluid material in multiple lifts. Technical challenges include:
   a. competing requirements of fluidity and shrinkage
   b. shrinkage required the incorporation of an ultra-fine aggregate.
   c. Laboratory evaluation of both plastic and hardened properties is discussed.

4. Field applications
   a. The first engineering use of this low-strength grout was in the fall of 2012, on a massive church tower in the northeastern United States.
   b. A second formulation was created for smaller-scale use as an injection grout by conservators of architecture and sculpture.
   c. Continued field work with the grouts has led to the development of a number of other conservation materials.
      i. The first was a paste-consistency crack filler, largely based on the injection grout.
      ii. More recently, research with the original grout has resulted in the creation of a mortar that is suitable for the pointing of the exceptionally narrow “butter joints” that are seen in many brick buildings of the second half of the 19th century.
      iii. For conventional joints, two lime-pozzolan mortar binders have also been formulated; they are designed to be mixed with local masonry sand, to replicate historic mortars.

CS08-3: Modification of Akoustolith Properties at Washington National Cathedral
Marlene Goeke and Joseph Myers

1. Introduction
   a. Washington National Cathedral construction history
   b. Use of Akoustolith in the Cathedral
      i. Why Akoustolith was used
      ii. Where it was used
      iii. Problems with Akoustolith in the Cathedral
   c. Prior evaluations and recommendations
   d. Earthquake repairs project/organ restoration

2. Testing Program
   a. Discussion of potential methods to increase reverberation
   b. Agreed upon method: coating Akoustolith with clear acrylic
   c. Methodology
      i. Testing efficacy of acrylic coating
      ii. Ensuring limited visual impact
   d. Initial samples
i. Installation
ii. Evaluation
   1. Cross sections
   2. Visual examination
e. Large-scale sample panels
   i. Visual examination
   ii. Acoustical testing
f. In situ mock-up (for visual review)

3. Acoustical Testing
   a. Baseline data
      i. Discussion of initial findings for Akoustolith and limestone
      ii. Desired outcomes once coating is complete
   b. Testing of large-scale sample panels
      i. Theory and instrument set-up
      ii. Execution of testing
      iii. Results and recommendations

4. Implementation
   a. Implementation method and where acrylic coating was applied
   b. Results
      i. Visual impact
      ii. Effect on overall acoustics after treatment

CS08-4: Exploring the Adaptability of Terra Cotta Flat Arch Systems – an Engineering Approach
Rebecca Buntrock and Derek Trelstad

I. Introduction
   a. Brief history/context for use of terra cotta flat arch floors in building construction
   b. Floor system components
   c. Types of systems (end pressure versus side pressure construction)
   d. Mechanisms of how terra cotta flat arch systems structurally resolve load
   e. How are floor systems treated by the current building code from a structural (load) and architectural (fireproofing) perspective

2. Challenges with Adaptability
   a. Change in load on the floor system, including point loads and line loads (heavy walls)
   b. Penetrations, attachments, and openings in existing slabs, reliability of tie rods
   c. Repairs to deteriorated slabs
   d. Condition assessment when terra cotta is hidden by plaster ceiling
   e. Considerations to be discussed with design team (owner, architect, engineer, contractor) before construction begins

3. Structural Analysis and Research
   a. Design based on empirical data versus modern structural analysis
   b. Historic method of quantification – load testing and empirical design; analytical methods (using
      graphic statics or elastic theory) were not developed by manufacturers
   d. Mechanisms of deterioration
   e. Correlation between condition and structural capacity, risk analysis
   f. Stability analysis (thrust line) for a range of loadings and damage conditions.
   g. 3D FE modeling

4. Conclusions and Recommendations