Session Track: Brick
Session Code: CS03a

Paper: Misunderstanding Masonry Construction

Presented by
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Speaker(s) Biography
The author has architecture degrees from Tulane and Columbia, and an engineering degree from NJIT in structural analysis. He runs an architecture/engineering firm in New York City that specializes in historic structures.

Abstract
Masonry structures generally have a straight-forward load path, especially if the openings align. The paper discusses a column relocation project that went bad, leading to the demolition of the structure. Inappropriate assumptions about the behavior of the structure and the load paths lead to the development of a design that would not have suported the wall without cracking.

The various assumptions that were made and the problems with each will be detailed, using geometric and algebraic methods. The presence of arches, wood lintels and openings all affect the load paths, in the existing and proposed structure. The failure to account for the stiffness and weakness of each of these elements and the effect of their presence on the load path and load transfer during construction will be demonstrated.

The need for bracing of the wall during construction, at the various stages of construction, and the changing bracing requirements will be demonstrated. The effects of the failure to brace the wall will be shown.

The construction problems that lead to failure prior to the column removal, the emergency shoring design and installation, alternate propsoals and the removal and re-building of the structure will illustrate the problems with simplifying assumptions about masonry behavior. A generalization about the behavior of masonry walls undergoing load transfer and concentration of loads due to removal of portions of the wall will be made, and a separate project, removing 20' of interior bearing walls at the same structure will be shown, to demonstrate the value of the generalizations.

Session Track: Brick
Session Code: CS03b

Paper: Tear on the Dotted Line: Hidden Weakness in Complex Brick Walls

Presented by
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Speaker(s) Biography
Donald Friedman is a structural engineer for historic and old buildings, working for owners, preservation consultants, architects, contractors, and other engineers. A professional engineer with twenty years experience in the investigation, analysis, and restoration of landmark buildings, Mr. Friedman holds a B.S. in Civil Engineering from Rensselaer Polytechnic Institute and an M.A. in Historical Studies from the new School for Social Research.

Mr. Friedman's design experience includes the integration of modern construction into existing buildings with archaic and obsolete structural systems; repair and restoration of steel, masonry, iron, wood, and concrete structures; and the investigation of historic buildings to determine structural type and condition. His work has included managing historic preservation, structural design, and investigation projects, including the development of details for combining new and historic structures, and designing repair and restoration techniques. Representative projects include structural design of repairs to the crypts at the landmark New York Marble Cemetery; structural condition assessment of the landmark 1848 John Street Methodist Church in New York; facade analysis and review of repair design for the 1928 Hearst Magazine Building in New York; and structural investigation and repair to the tower of the landmark Church of the Holy Trinity in New York.

Mr. Friedman has helped develop the field of conservation engineering – building evaluation and design that conforms to the core values of both structural engineering and historic preservation. He teaches engineering of historic buildings in the Building Conservation Program at the Rensselaer Polytechnic Institute; he is the author of the books "After 9-11: An Engineer's Work at the World Trade Center," "Historical Building Construction" and "The Investigation of Buildings," and the refereed papers including "Methodology of Conservation Engineering," "Cast-Iron Columns in Renovation Design", and "Ambiguity in Building Investigation."

Abstract
Brick is among the oldest construction materials but has changed over time. During the nineteenth century, as construction was transformed by industrialization and mass-production, massive and multiply-interlocked walls were replaced by thinner, sometimes hollow, and more independent walls. Brick bearing-wall buildings of the mid- and late-nineteenth century contain relatively complex assemblies, some with inherent defects.

For example, two common aspects of rowhouse construction were poor designs resulting from the effect of economic pressure on construction practice: over-use of party walls and non-simultaneous construction of party walls and facades. Party walls are not in themselves flaws, but when used for all of the bearing walls in a building (common in rowhouses) they allow poor construction quality or ill-advised alteration of a neighboring building to cause long-term brick movement. Non-simultaneous construction is more interesting in that construction sequences rarely create problems that persist after

construction is complete. A common practice among rowhouse builders was to erect first the side walls and the wood joists resting on those walls, and then to add the front and rear facades. The facades are less-solidly connected to the side-wall masonry then if all had been built together. Some technological innovations caused more trouble than they eliminated. The rowlock wall, for example, was a nineteenth-century creation that used brick headers to connect two or more isolated wythes of stretchers. Unlike modern cavity walls, the central cavity was not designed to control water, as it did not have the waterproofing, flashing, or weeps necessary to work as a rain-screen. However, the air trapped in the cavity improved the wall's insulation and allowed a given amount of brick to create a thicker wall than one constructed solidly. The distinction between a thicker wall and a stronger one is perhaps more clear now than it was at the time of construction.

A rowhouse in Brooklyn can serve as a case study because it is typical of many small residential and commercial buildings constructed in American cities. The three-story-and-basement house was built as part of a still-extant row, and is 22 feet wide by 48 feet deep with party walls on both sides. The front and rear facades are also continuous with the facades of the neighboring houses. The conditions present are a catalog of weaknesses in aging brick walls: the use of a rowlock party wall reduced the bracing of the individual wythes of brick to only partially-embedded headers; the front and rear facades were poorly tied to the side walls; abandoned chimneys had been left uncapped, allowing water entry and resulting in advanced mortar deterioration from the inside of the wall outward; wood baseboard nailers interrupted both wythes of the rowlock wall; and an alteration in the adjoining building changed the lateral bracing of the wall. These multiple problems had quite serious consequences: one party wall was buckling sideways at every floor and had detached from the street facade, while the unbraced street facade was bulging towards the street.

This description of defects is, of course, based on conditions seen during investigation and repair. Before work began, visible damage included a large bulge in the party wall in the stair between the basement and cellar and, more disturbingly, a continuous outward "roll" bulge immediately above the first floor baseboard molding. The investigation of this damage uncovered the multiple defects and led to repair and reconstruction of more than sixty percent of the wall.

Session Track: Brick
Session Code: CS03c

Paper: Mortar Injection: European Techniques for an American Construction

Presented by
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Speaker(s) Biography
Mary B. Brush is a licensed architect in Illinois and the Director of Preservation at Klein and Hoffman, Inc in Chicago. She specializes in the restoration of building envelopes on buildings with simple to complex geometries, such as historic high rises, churches and theaters. Projects of note in Chicago are the restoration of the exterior walls of The Monroe Building by Holabird and Roche, Louis Sullivan's Gage Building and of Burnham and Root's Rookery Building. She is the 2005 laureate of the Richard Morris Hunt Fellowship, a professional honor for which one American architect is chosen every two years to meet and work with restoration architects and professionals throughout France for six months. The fellowship is an exchange of information, techniques and professional practices of architects and practitioners in the preservation fields of each country. Didier Repellin is a chief architect for historic monuments in France. One of his projects is the restoration of the French owned Villa Medicis in Rome Italy, which is the primary case study of this presentation. He is one of the elite restoration architects of France and his domain of responsibility includes Lyon, Provence, Lille, and Rome. Recent projects have included the Theatre Antique d'Orange, the Cathedral St. Jean of Lyon, and the Pont Saint-Bénezet of Avingnon.

Abstract
Masonry walls are a challenge for preservation architects and engineers worldwide. Time, water and gravity each contribute to the reduced structural capacity of masonry walls. How can the walls regain integrity and retain authenticity? This presentation will discuss the technique of mortar injection of masonry walls and how this technique has become common practice in France and Italy.

A building with deterioration issues requires analysis and thorough study of the pathologies at work as well as the options for the stabilization and restoration. Solutions that are deemed acceptable in the United States such as steel interventions in masonry walls or reconstruction are controversial in Europe and France in particular. Likewise, a standard practice in Europe such as the injection of mortar within a masonry wall is rarely performed in the United States. The primary challenge is accepting the empirical approach to historic buildings - they have stood for decades/centuries, and will continue to do so, but require our assistance at the present moment. What can be done to retain the integrity of the structure, the craftsmanship of the original masons, and be historically sensitive in our technical approach to the building? Can that be accepted by the building codes? Should our approach to preservation issues and historic buildings be concerned with the interior coursing of stone and brick walls to the extent of retaining it all, and strengthening around it - or are we only concerned with the finish surface? If the building is primarily masonry, why would we consider a steel intervention, where steel has not previously existed? Our repair processes should become more holistic and design the solutions using the original materials, with a modern enhancement.

The problem is weak masonry walls, the solution is mortar injection. The requirement is to have load bearing brick or stone masonry. The option of mortar injection and various supplemental support

systems will be discussed. The case study involves the Villa Medicis in Rome Italy. The project included understanding the problems within the walls first constructed in 1564, and designing a solution to satisfy historic preservation and building officials in both France and Italy. The challenge will be presented if European architects, engineers, and regulatory officials can accept it, what is necessary to make this process acceptable in the United States?

The paper and presentation will discuss alternate options for resolving the challenges of masonry walls preservation, and the options pursued for the Villa Medicis. The goal is to open a dialogue to pursue additional options that current regulations may not yet find acceptable. How can we to resolve the needs of structural and architectural regulations within a framework of building restoration?