

3/7/07

NESEA Conference Thursday March 15, 2007 10:30-12:00

World Trade Center Boston

## Case Studies of Exemplary Historic Rehabilitations

### Pushing the Envelope - Bruner Cott & Assoc.

*The objective of this talk is to help building owners, managers and designers think about significant improvements to the thermal performance of exterior walls built of mass brickwork in existing or historic buildings.*

#### **Introduction:**

- Bruner/Cott: who we are: Architects and Planners specializing in rehabilitation of existing and historic buildings.

While we have found LEED guidelines to be invaluable tools for green building, we were proponents of environmentally sensitive and sustainable design well before the advent of LEED. Adaptive reuse and building preservation have been hallmarks of Bruner Cott's from the beginning. Our Architectural record "Cover House of the Year" for 1977 was recognized as an excellent passive solar design. It was the only custom home of its time awarded for outstanding design achievement and energy efficiency.

- Past projects exemplifying sustainable techniques in existing buildings:
  - Arsenal on the Charles: Embodied energy
  - Mass MoCA: Adaptive reuse
  - Landmark Center: Indoor Air Quality
  - Channel Center: Embodied Energy

Typical of these buildings are their exterior walls historically having no interior insulation which have been drying both to the exterior and interior. This has become a challenge for owners and architects to meet the energy code or ASHRAE 90.1 requirements for optimal energy performance toward LEED certification.

#### **Case Study:**

Harvard UOS Blackstone Renovation Project: Vapor Migration and Exterior Wall Insulation

1. Project background
  - Client: Harvard University Operation Services includes Maintenance depts. and Harvard Green Campus Initiative
  - Historic site adjacent to Charles River, raised first floors, no separate storm sewer, heavy oil truck delivery traffic and car parking, high winds and sun from river
  - Historic buildings (3) 100yr old masonry buildings merged into a single structure (40,665sf)
2. Program:
  - Convert to office uses (bringing 9 departments together)
  - LEED Gold target and demonstration project
    - Energy management
    - Water resource management
    - Clean environment (indoors and out)
3. Energy Management Strategy
  - Passive Measures*
    - Reduce square footage of exterior exposure with a glazed connector that encompasses the alley between buildings into the interior

- Increase human comfort level with operable windows and extended “Dead Zone” and no blown air systems
- Insulate exterior walls to enhance thermal performance of building envelope
- Heating hot water provided by steam from the adjacent Harvard Steam Plant
- Chilled water provided by ground-source heat pumps and open-column wells for heat rejection
- Two pipe valance units heat and cool the majority of the building with no
- A single air handling unit provides 100% outside air with an enthalpic heat recovery wheel (80% recovery)

4. Existing conditions

Existing Wall condition:

- 16” brick solid masonry supporting beams and deck
- Condition: fair with typical pointing and brick failures at chimneys, parapets, band courses and sills
- Existing 16” wall has an R-value of about R-2.5 @ 0.15/inch thickness.
- Vapor retarder exists at interior surface paint
- Wooden double-hung sliding sash, single-glazed windows
- Existing punched window openings equal 23% of exterior wall.
- Interior spaces: high, open, no ceilings, few separate rooms

Existing roof condition:

- Existing 4” wood T&G decking in good condition

**Managing the building envelope**

5. Design Goals:

- Enhance thermal performance of the building envelope to reduce energy consumption and to meet ASHRAE 90.1 LEED prerequisite
- Replace windows reducing air infiltration and conductive heat losses
- Allow for cooler masonry
- Allow exterior wall to dry in both directions

6. Concerns:

- Interstitial condensation in the wall thickness
- Free moisture that never dries in the wall thickness
- Condensation on the interior face of the exterior wall
- Free moisture on the cavity face of the GWB that could lead to mold
- Condensation on metal studs that could affect GWB and lead to mold
- Orientation and vulnerable exposures
- Pointing and exterior masonry openings or defects
- Porous bricks
- Special exposure to absorption (ledges, single- and double-wythe construction, parapets, steel lintels, soffits and rafter penetrations)
- Window flashings
- Vapor pressure (heat and direction)
- Vapor migration
- Permeance of materials in wall assembly
- Moisture sources / direction
- Moisture retention and mortar damage

- Moisture retention and freeze/thaw damage
- Ventilated cavities
- Thermal bridges
- What examples of comparable installations exist with long time horizons?

7. Strategies:

- Research: Exterior wall consultants providing quantitative comparisons and modeling (WUFI, ROOM, etc.), 2D and 3D building studies: John Straube, Balance Solutions, Waterloo Ont.; Thompson & Lichtner, Cambridge Ma.; Marc Rosenbaum, Energysmiths, Meriden NH.
- Provide exterior masonry repairs
- New windows w/ Rvalue of 4
- Walls Rvalue of 15.80
- Roof Rvalue
- 3 options of wall insulation: Pros/cons of each
- Preferred solution
  - Properties of Icynene
    - Icynene is a polyisocyanurate expanding foam, free of HCFs and HFAs and detectable VOCs
    - Expands 100 times its volume (99%air, 1% water)
    - 100% water blown environmentally friendly material
    - How does Icynene prevent water in brick wall from affecting GWB and still allow vapor to move into cavity?
- Once past R-8 to R-10, increasing R-value does not make wall colder.
- Owner's acceptance program and their role in maintenance
- Monitoring

**Summary:**

8. It is possible to insulate existing heavy masonry walls
  - Low-density foam (Icynene)
  - R-value
  - Thickness variation for permeance
9. Insulating Roofs (Exposed Decks Below)
  - R-value of roof insulation
  - R-value compared to walls
  - Visible thickness of roof
  - Installation
10. Performance Post-Occupancy Followup
  - Benefits to owner
  - Managing the owner's expectations
  - Record meter data for improvement above base line energy consumption
  - Observable moisture problems with a monitoring system
11. Precedents
  - Canadian Home Mortgage Commission (verify)
12. Bibliography