Castle Square Mid-Rise Retrofit

**Project Overview:**
- Occupied rehabilitation
- 1960’s era, brick and concrete public housing structure
- Majority owned by residents association

**Castle Square Mid-Rise Retrofit**

**Project Objective:**
- Leverage tax incentive financing, grants, incentives, technical support, etc. to include Deep Energy Retrofit in rehabilitation scope
- Rehabilitation of otherwise limited scope

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Commercial Deep Energy Retrofit: Castle Square Case Study
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Castle Square Mid-Rise Retrofit

Project Overview:
– Owner: Castle Square Tenants Organization, Winn Development
– Location: Boston, MA
– Buildings: 4 Buildings, 7 stories (6 Residential over Ground Floor Commercial)
– Units: 192 Units, 48 Units/Building, 600-900 sq. ft./Unit

Circumstances of the Project

• 51% Tenant Owned
  ➢ CSTO in charge
  ➢ Interests of tenant group protected
  ➢ Driving factors for the “energy” measures: Comfort, IEQ concerns

Circumstances of the Project

• Originally built as subsidized housing
  – Small, compact apartments
  – Economy of layout
  – Structure affords no opportunity to run services in interstitial spaces,
  – Structure and aesthetic expression poses challenge to thermal performance

Circumstances of the Project

• 100% occupied renovation (!!)
  – Severe constraints on scope within apartments
    • Completed over 2-3 days
    • Tenants return to functioning kitchen first day
    • Belongings in bedrooms, living room not moved
Resident Surveys & Charrettes

Top Resident Concerns:
1. Poor Ventilation
2. Comfort (Too Hot or Cold)

Castle Square Mid-Rise Retrofit

Property Management Concerns:
- IAQ
- Comfort
- Energy costs
- Water leakage
- Façade maintenance and repair issues

Project Overview:
- Ambitious energy performance goals
  - Estimated Heating and Water Heating Energy Savings: >70%
  - Combined Gas & Elec. Savings: >50%
- Construction Start: October, 2010
- Construction Schedule: 18 Months
Castle Square Mid-Rise Retrofit

- Energy costs!
- Odors
- Spalling concrete
- Air quality
- Aesthetics
- Poor comfort
- Outdated kitchens

What do we have to work with?
Understanding the building through:
- Testing/measurement
- Investigation of construction
- Simple analysis

Castle Square Mid-Rise: Testing

Photo of testing equipment and people.
Testing and Measurement:

- Leakage to outside (guarded testing)
  - ~2.5 ACH50
  - ~0.7 cfm50 / sf exterior enclosure

- Total leakage for apartment units (unguarded)
  - ~10-17 ACH50
  - ~0.5-0.8 cfm50 / sf total enclosure
Castle Square Mid-Rise: Investigation

Existing Enclosure:
- ~R-20 Roof Insulation
- Exposed concrete frame with **uninsulated** brick cavity wall infill
- Aluminum Frame Windows (assumed no thermal break in frame, no Low-E)

Image courtesy of Elton + Hampton Architects
Castle Square Mid-Rise: Investigation

Castle Square Mid-Rise: Investigation

Castle Square Mid-Rise: Analysis

Simple Analysis
• UA analysis
• Estimates of ventilation, infiltration

Castle Square Mid-Rise: Analysis

Castle Square Mid-Rise: Analysis
Castle Square Mid-Rise Retrofit

Testing, investigation, analysis:

• Building is moderately (but not abnormally) air leaky
• Apartment units are not well contained
• Any significant improvement to energy performance will require adding insulation to walls

Castle Square Mid-Rise Retrofit

Testing, evaluation, analysis:

• High performance will require
  1. adding insulation to walls,
  2. controlling infiltration and ventilation,
  3. improving windows

Castle Square Mid-Rise Retrofit

Performance Targets:

— R-40 Walls
— R-5 Windows
— R-40 Roof
— Improve compartmenting as much as possible
Castle Square Mid-Rise Retrofit

1. **super insulate**
   - Super insulated reflective roof (R-40)
   - Air sealant/painted onto existing wall
   - Super insulated exterior wall panels (R-40)
   - Insulation (R-5)

Image credit: www.CastleDeepEnergy.com

Castle Square Airflow Control/Ventilation

- Avoid cross-contamination
- Provide effective ventilation with minimal energy inputs
- Reduce drivers of infiltration
- *Compartmenting of apartments is critical to ventilation performance*

Castle Square Mid-Rise Retrofit

2. **air seal**
   - Air sealing between apartments & outdoor air
   - Insulation (stemmer)
   - Air sealing between apartments & each other
   - Compartimentalization
   - Air sealant (windbreaker)

Image credit: www.CastleDeepEnergy.com

Ventilation
Ventilation

Context:
• Odor complaints a major motivation for residents
• Exhaust ventilation a part of existing infrastructure
• Project aspiring to LEED-NC recognition (ventilation distribution requirements)

Ventilation

Challenges:

Options investigated:
- HRV per apartment
  • Ceiling too low for dropped soffit in circulation areas
  • Asbestos made penetration of partitions impractical
- Central supply and Hx
  • Would need to refit or reconfigure riser
  • Distribution within apartment

Selected approach:
- Use existing ventilation shafts, exhaust
  - Controlled rate at unit – CAR
  - Seal exhaust riser from roof
  - Passive inlet vent (PIV)
Ventilation
Whither the ventilation supply:
• Passive Inlet Vents (PIV)
  – Concern about effectiveness of passive vents
  – Act as intake only when apartment negative WRT exterior
  – Could exhaust ventilation act to depressurize enough – depends on how tight apartment is
  – Is source controlled?
Compartmenting

Context:
- Odor complaints a major motivation for residents
- Project aspiring to LEED-NC recognition (apartment air tightness requirement)

Compartmenting

Challenges:
- Occupied renovation severely limits opportunities
  - 2 – 3 days total for interior work
  - Belongings not moved from living and bedrooms
- Interstitial interconnected
  - Openings into shafts
  - Hollow walls
- Limited disruption beyond kitchen and bath

Compartmenting

How to identify effective and important measures?
- Have a look at building
  (may have to get destructive)
  - Understand/confirm construction
  - Assess significance of holes
  - Devise approaches to seal holes
  - Test implementation of measures.
Castle Square Wall Insulation Strategy

Context
– Buildings are un-insulated
– Significant air leakage comfort complaints (papers blowing off of desks)
– Exterior rain infiltration issues
– Façade maintenance issues
– *R-40 performance goal*

Challenges:
– Occupied Retrofit
– Significant Thermal Bridging of Concrete Structure
– Existing Building Construction Tolerances
Castle Square Wall Insulation Strategy

Options pursued:
– Exterior air barrier, insulation and cladding
– Exterior insulation and finish system (EIFS)
– Insulated metal panels (IMP)

Castle Square Wall Insulation Strategy

• Exterior air barrier, insulation, and cladding

Castle Square Wall Insulation Strategy

• Exterior air barrier, insulation, and cladding:
  – Large range of options
    • Insulation types
    • Air barrier materials
    • Cladding options
  – Fire concerns
    • Lack of UL rated assemblies
  – Insulation thickness needed to achieve desired R-Value could be significant
Castle Square Wall Insulation Strategy

- Exterior insulation and finish system (EIFS)

Castle Square Wall Insulation Strategy

- Exterior insulation and finish system (EIFS)
  - Lower cost option
  - No need for design of cladding attachment system

Castle Square Wall Insulation Strategy

- Exterior insulation and finish system (EIFS)
  - Thick layers of insulation needed to achieve design goals
  - Insurance concerns (Fire, water, durability)

Castle Square Wall Insulation Strategy

- Insulated metal panels (IMP)
Castle Square Wall Insulation Strategy

- Insulated metal panels (IMP)
  - High R-Value – thinner overall thickness
  - Fire rated
  - Durable

Castle Square Wall Insulation Strategy

- Insulated metal panels (IMP)
  - Attachment due to building variances
  - Water and Air control approach:
    - Use panels as the complete enclosure? (air barrier, insulation, water management)
    - Use the panels as an insulated cladding with another air barrier and water management layer behind?

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Insulated metal panels (IMP) as complete enclosure:
Castle Square Wall Insulation Strategy

- Insulated metal panels (IMP) with separate water/air control:

Wall System Approaches for Super Insulation (R40) Retrofit

2. Field-constructed system
   - separate components: applied air barrier and drainage plane, cladding attachment, exterior insulation, and cladding;
   - judged to costly and complicated

2. EIFS (Exterior Insulation and Finish System)
   - required thickness not approved by insurance

3. Insulated metal panel system
- Insulated metal panels (IMP)
  - Integration of windows and other enclosure elements made at the air barrier/water resistive barrier location
Building Enclosure