

Ken Neuhauser
October 17, 2013

High Performance Exterior Retrofit Options for Masonry Walls in a Cold Climate

8th Annual North American Passive
House Conference



Who am I and why am I here?

Ken Neuhauser, M. Arch, MSc. Arch

Building Science Corporation,

www.buildingscience.com

- Building America Research Team
- Building science consulting



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What is this all about?

High performance retrofit strategy for

- Masonry wall enclosure
- Cold climate
- Occupied



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Building 1, Pre-Retrofit



Image credit: Biome Studio / www.castledeenergy.com



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Building 2, Pre-Retrofit



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Building 3, Pre-Retrofit



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Building 3, Pre-Retrofit



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Building 1, Insulated Metal Panel



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Building 2 & 3, Fiber-Cement over Rigid



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High Performance Masonry Wall Retrofit

- Why Outside?
 - Occupied building
 - Outside is ugly
 - Preserve building
 - Performance



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Why Outside – Outside is Ugly?



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Why Outside – Outside is Ugly?



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Why Outside – Outside is Not Pretty



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High Performance Masonry Wall Retrofit

- Why Outside?
 - Occupied building
 - Outside is ugly
 - Preserve building
 - Performance
- Refer to previous presentation re:
 - Water vapor
 - Bulk water



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High Performance Masonry Wall Retrofit

- Why Outside?
 - Occupied building
 - Outside is ugly
 - Preserve building
 - Performance

Simplified geometry = better continuity



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High Performance Masonry Wall Retrofit

- Why not EIFS?
 - Plastic
 - Combustible
 - Not abuse resistant
 - High thermal resistance is really thick!



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Building 1, Castle Square Mid-Rise

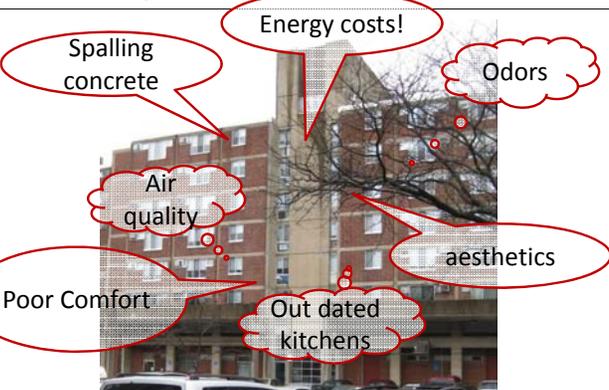


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Castle Square Mid-Rise



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Castle Square Mid-Rise

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)

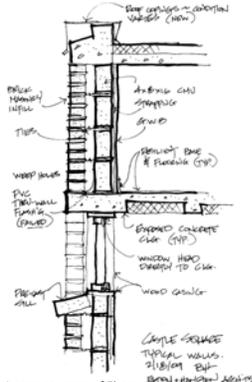


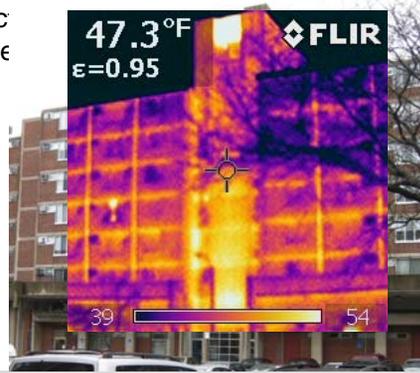
Image courtesy of Elton + Hampton Architects

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Castle Square Mid-Rise

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Castle Square Mid-Rise Retrofit

Testing, evaluation, analysis
concludes:

High performance will require

- adding insulation to walls,
- controlling infiltration and ventilation,
- improving windows



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Castle Square Wall Retrofit Strategy

Performance Targets for Wall:

- R-40
- Improve compartmenting as much as possible

Options considered:

1. Exterior air barrier, insulation and cladding
2. Exterior insulation and finish system (EIFS)
3. Insulated metal panels (IMP)

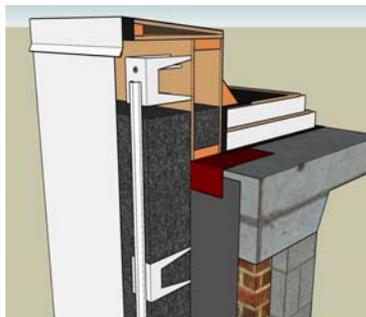


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Castle Square Wall Retrofit Strategy

1. Exterior air barrier, insulation, and cladding



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Castle Square Wall Retrofit Strategy

1. Exterior air barrier, insulation, and cladding

Large range of options with respect to

- Insulation types
- Air barrier materials
- Cladding options



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Castle Square Wall Retrofit Strategy

1. Exterior air barrier, insulation, and cladding
 - Fire concerns
 - Lack of UL rated assemblies
 - Insulation thickness needed to achieve desired R-Value could be significant

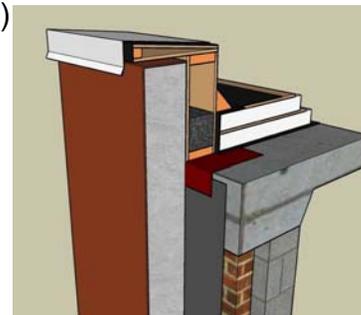


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Castle Square Wall Retrofit Strategy

2. Exterior insulation and finish system (EIFS)



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Castle Square Wall Retrofit Strategy

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



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Castle Square Wall Retrofit Strategy

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

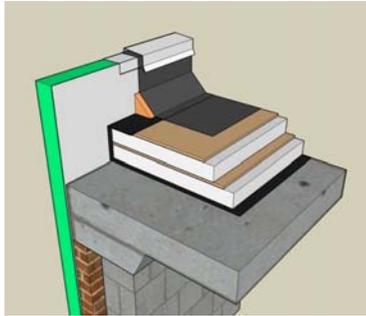


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Castle Square Wall Retrofit Strategy

3. Insulated metal panels (IMP)



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Castle Square Wall Retrofit Strategy

3. Insulated metal panels (IMP)

- High R-Value – thinner retrofit profile
- Fire rated
- Durable



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Castle Square Wall Retrofit Strategy

3. Insulated metal panels (IMP)

- Attachment over non-plumb/plane surfaces
- Cost
- Question of Water and Air control approach



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Castle Square Wall Retrofit Strategy

▪ Wall System Approaches for Super Insulation (R40) Retrofit

1. 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



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Castle Square Wall Retrofit Strategy

Insulated metal panel (IMP) challenges

Attachment over non-plumb/plane surfaces

- Requires panels spaced off wall <!>

Question of Water and Air control approach:

1. Panels as the complete enclosure?
 - Panels provide air barrier, insulation, water management
2. Panels as an insulated cladding?
 - Separate water and air control behind

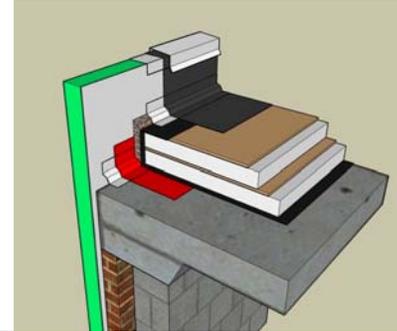


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Castle Square Wall Retrofit Strategy

Insulated metal panels (IMP) as complete enclosure:

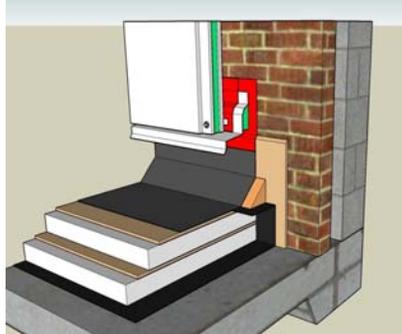


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Castle Square Wall Retrofit Strategy

Insulated metal panels (IMP) as complete enclosure:

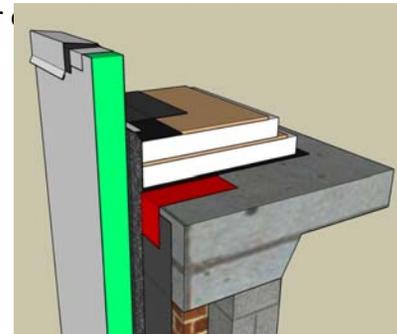


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Castle Square Wall Insulation Strategy

Insulated metal panels (IMP) with separate
water/air

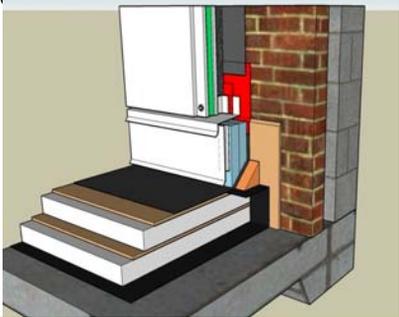


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Castle Square Wall Retrofit Strategy

Insulated metal panels (IMP) with separate water/air



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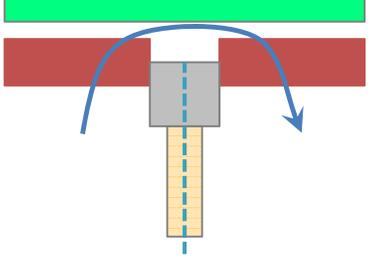
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- Insulated metal panels (IMP)
 - Compartmentalization of the living units

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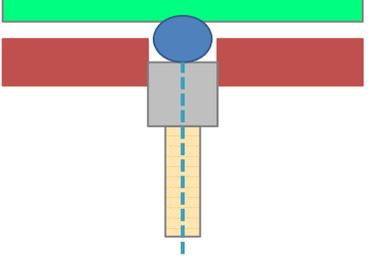
- Compartmentalization?



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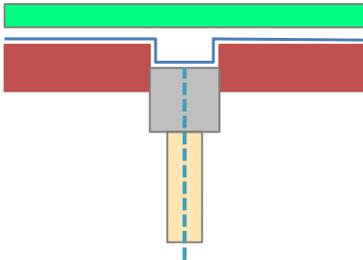
- Compartmentalization?



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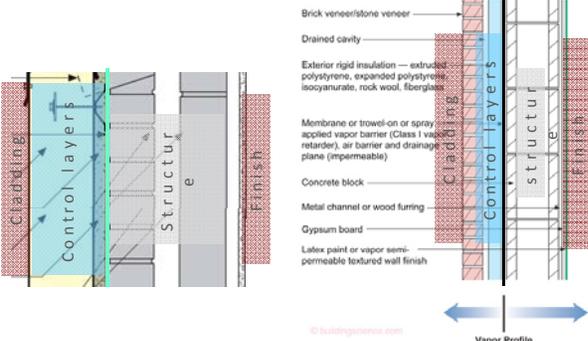
- Compartmentalization!



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Castle Square Wall Retrofit Strategy



Designed wall The “perfect wall”

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Castle Square Mid-Rise Retrofit

1 super insulate



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Castle Square Mid-Rise Retrofit

2 air seal

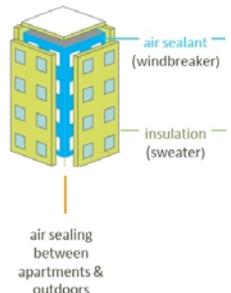


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Castle Square Wall Retrofit Strategy

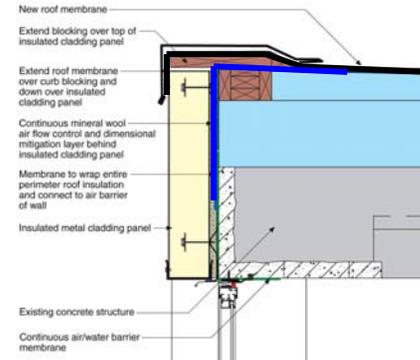
- Integration of control functions at windows, roofs, etc.



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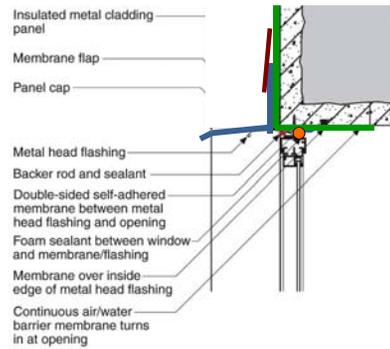
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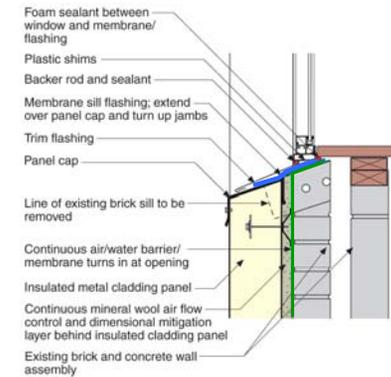
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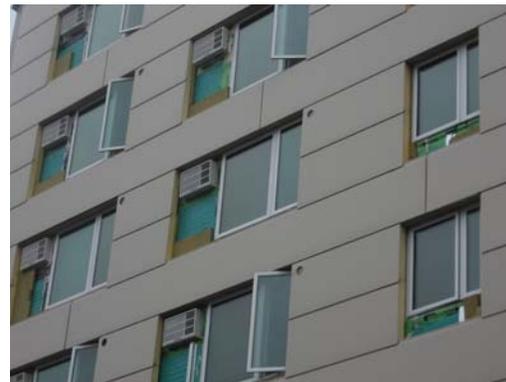
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Castle Square Retrofit

- Results from overall project:
 - > 50% gas savings
 - EUI: 58.5 kBtu/sf-yr
 - Gas for heating and hot water: 4.5 kBtu/sf-yr



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Brick Masonry Bearing Walls - Chicago

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Brick Masonry Retrofit - Chicago

Implementation through weatherization channels:

- Low cost solutions
- Implementation by Wx program contractors
- Employ readily available building materials

Location:

- Combustibility a major concern
- Abuse resistance

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Brick Masonry Retrofit Strategy

2x4 wood studs installed on the flat attached to masonry wall

Furring strips or hat channels attached back through the insulation to framing

Furring strips or hat channels attached back through the insulation to 2x4 wood studs

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Brick Masonry Retrofit Strategy

Section

Plan

Labels in Section: outside, inside, EXISTING MASONRY WALL STRUCTURE, EXISTING INTERIOR FINISH, FIBER-CEMENT CLADDING FASTENED TO STRAPPING AS PER MANUFACTURER INSTRUCTIONS, 1/2" POLYSTYRENE RIGID INSULATION SEAMS OFFSET HORIZONTALLY AND VERTICALLY RELATIVE TO PREVIOUS LAYER, 1/4" WOOD FURRING @ 24" O.C. ATTACHED TO WALL WITH MASONRY FASTENERS @ 16" O.C. VERTICAL, FULLY ADHERED AIR AND WATER CONTROL MEMBRANE APPLIED OVER SURFACE OF EXISTING MASONRY, 1/2" POLYSTYRENE RIGID INSULATION BETWEEN 2x4 WOOD FURRING.

Labels in Plan: outside, inside, EXISTING MASONRY WALL STRUCTURE, EXISTING INTERIOR FINISH.

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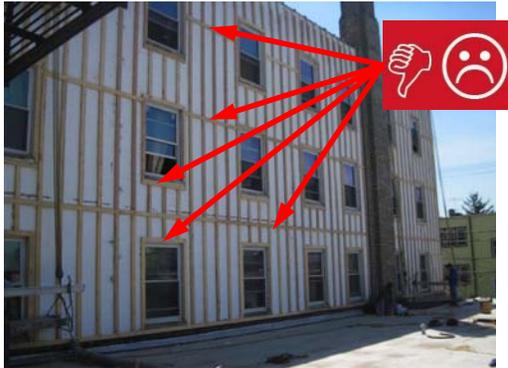
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Brick Masonry Retrofit – Existing Windows

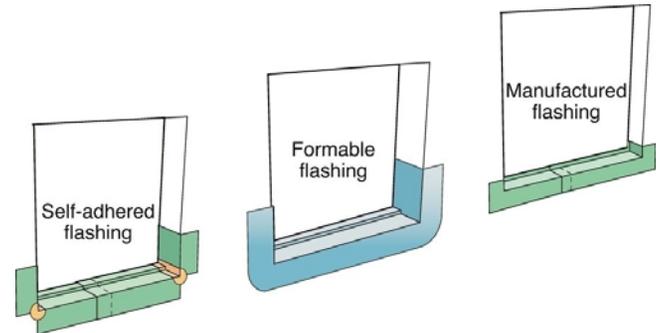
Window openings:

- Flashing
- Flanking losses (thermal bridges)
- Replacement

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Brick Masonry Retrofit – Windows



Self-adhered flashing

Formable flashing

Manufactured flashing

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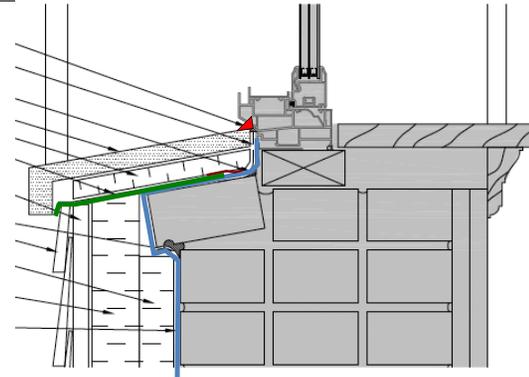
Brick Masonry Retrofit – Existing Windows



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Brick Masonry Retrofit – Existing Windows



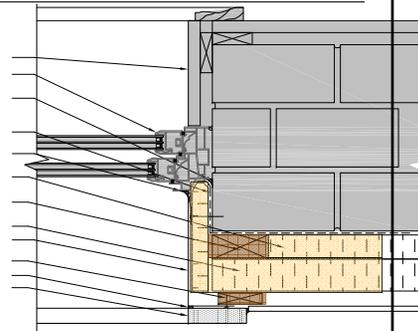
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Brick Masonry Retrofit – Existing Windows

Windows

- Flashing
- Flanking losses (thermal bridges)
- Replacement



REPLACEMENT WINDOW JAMB DETAIL



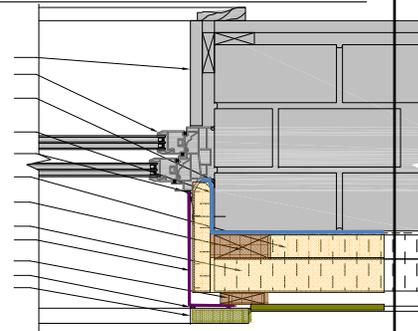
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Brick Masonry Retrofit – Existing Windows

Windows

- Flashing
- Flanking losses (thermal bridges)
- Replacement



REPLACEMENT WINDOW JAMB DETAIL



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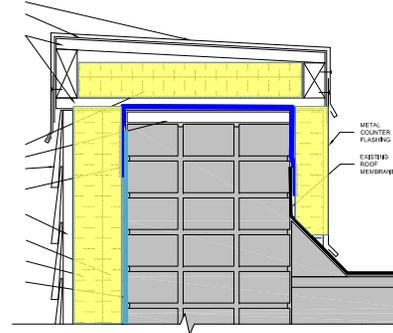
Brick Masonry Retrofit – Existing Windows



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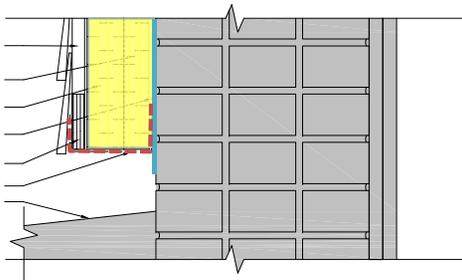
Brick Masonry Retrofit – Parapet



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Brick Masonry Retrofit – Parapet



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CEDA Wx Implementation – cost data

- 2 Story (Average of 3 lowest bids):
 - \$14.43 / s.f. gross wall area
- Post implementation contractor estimate:
 - \$12.60 / s.f. gross wall area
- Above 2 stories (Average of 3 lowest bids):
 - \$25.31 / s.f. gross wall area
- Post implementation contractor estimate:
 - \$20.10 – 21.30 / s.f. gross wall area



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