

Designing Commercial Energy Retrofit for Curtain Walls

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- ▶ **Building Enclosure Technology and Environmental Council
(BETEC)**
- ▶ **Symposium on Retrofitting Building Enclosures for
Energy Efficiency and Sustainability**
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Curtain Wall Definition

- A non-load bearing exterior skin (multiple substrates)
- Does not contribute to the structural support of the building
- Provides the air and water tightness of the building exterior



The Importance of the Building Envelope

- Protect against the natural elements
 - Key area to focus on contribution and managing energy loads on building
 - Maintenance is critical
 - The shelf life of usable materials
 - Provide aesthetic signatures to buildings
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Energy and the Building Envelope

- Need to Control Light Transmittance in Vision Areas
- Maintain insulation at Spandrel Areas
- Limit air and water infiltration
- Need to maintain or reduce mechanical loads on the interior.



Existing Curtain Wall Retrofit Challenges

- Often building is occupied
 - Building Owner's budget
 - Consider the age of the building
 - Architectural aesthetics
 - Site logistics (open or tight space for remedial access)
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Further Challenges

- Can elements be removed/replaced from the building?
- Can the remediation be extensive?
- Addressing tenants/employees during remediation?



Design Team Effort

- Paramount to assemble a good team
- Team can be combinations of professionals:
- Example:
 - ❖ Architect, Cladding Consultant, GC, System manufacturer reps (for input)
- Field Input on existing conditions and scheme



Design Approach

- System identification : Stick, Unitized, Panelized, Hybrid
 - Review the age of the building
 - Review the building usage type
 - Review the status of building material types (focusing on gaskets, framing , glazing, sealant)
 - Review system framing anchorage.
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Consider Aesthetics Also

- Very important element of the process
- Typically there is an opportunity to effectively change an appearance of a building while upgrading energy efficiency.



Curtain Wall Background



Design Tools

- **Building Codes**
- **Industry Standards**
- **Analytical Mechanics**
- **Installation Methods**

EXPERIENCE & their Lessons !!



Literature Reference

BUILDING CODES

- IBC, ASCE 7
- LOCAL CODES

INDUSTRY STANDARDS

- AA ~ Aluminum Association
 - AAMA
 - GANA
 - ASTM

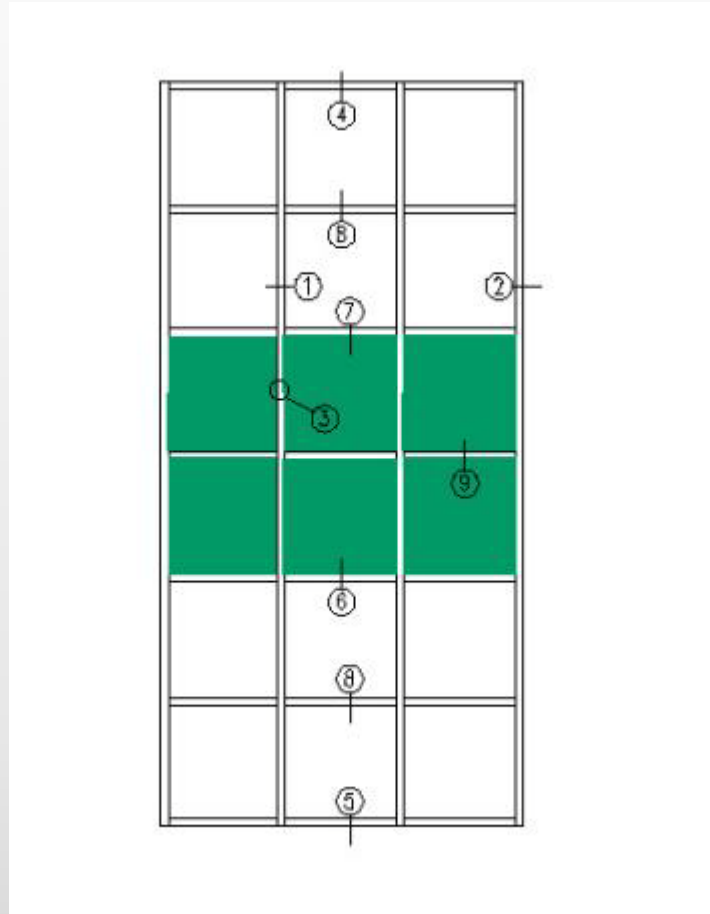
Curtain Wall Design Considerations

SYSTEM DESIGN

- Framing Elements
- Design Pressures
- Connections
- Air Flow Control
- Controlled Water Flow
- Shop Assembly
- Field Installation

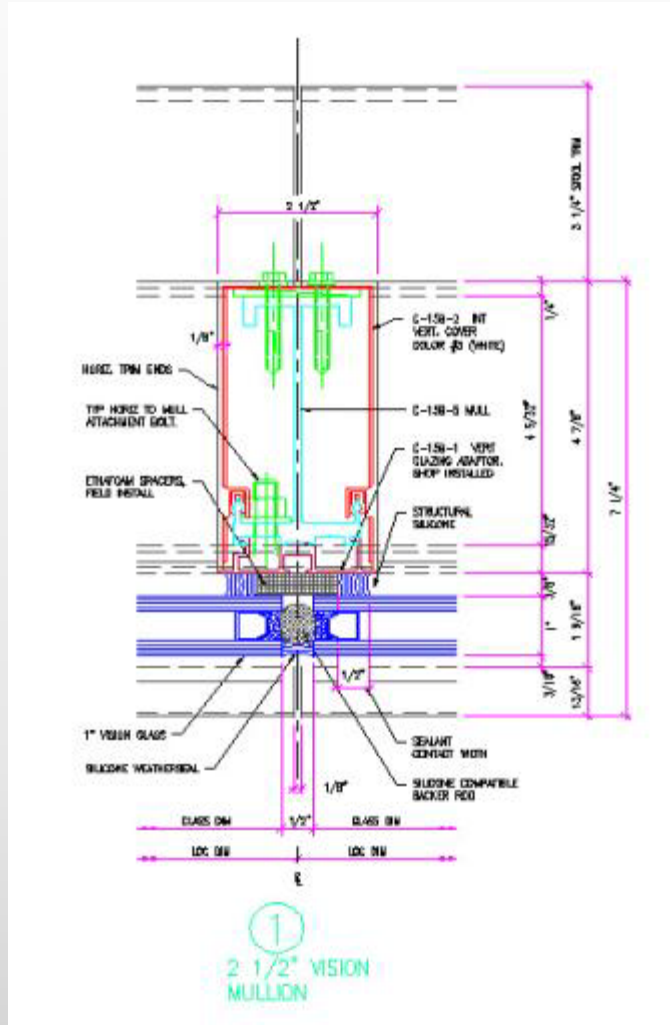


Typical Elevation



* Courtesy of Texas Wall Systems, Dallas, TX

Examples of System Types

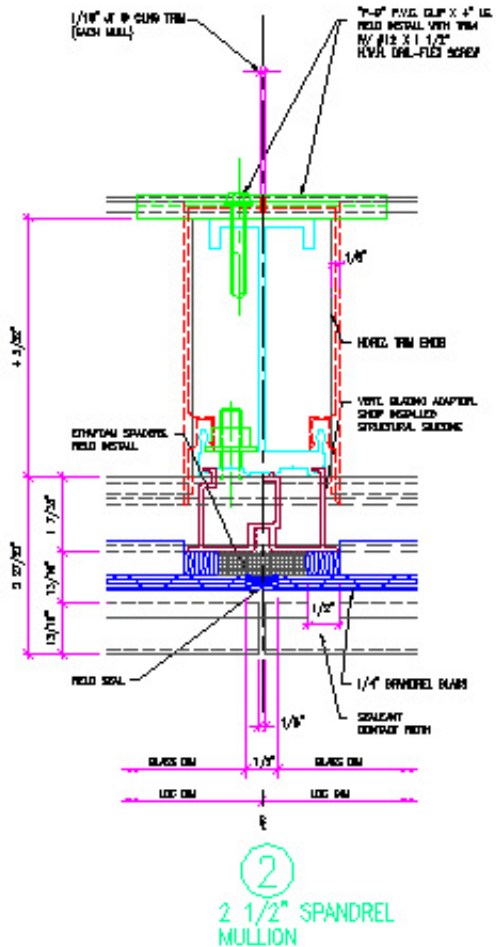


Butt Glaze
Mullion

Vision

* Courtesy of Texas Wall Systems, Dallas, TX

Examples of System Types



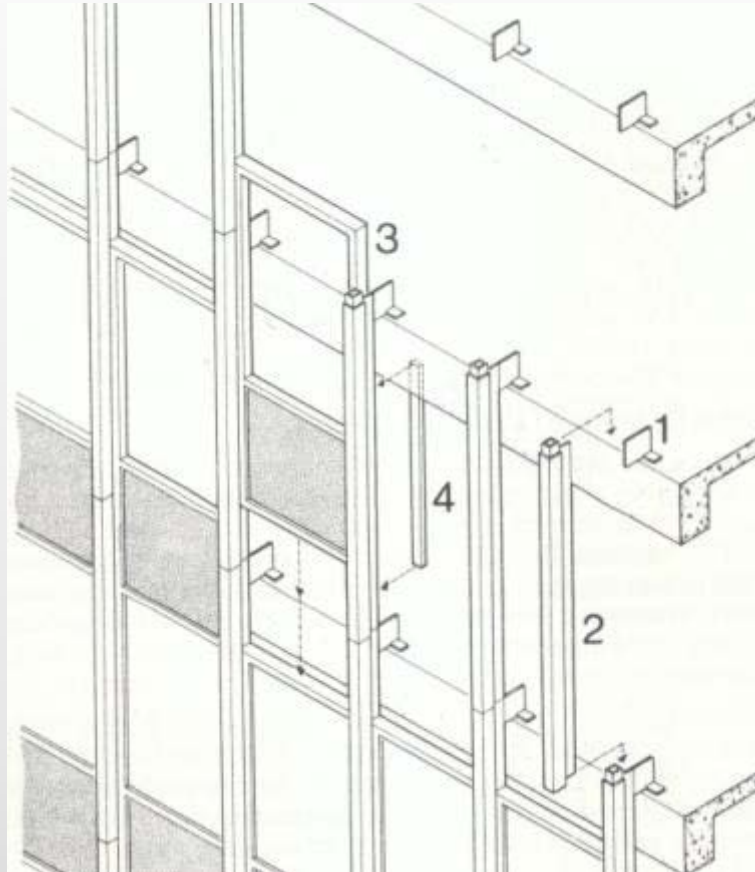
Butt Glaze Mullion Spandrel

*Courtesy of Texas Wall Systems, Dallas, TX

Stick System



Curtain Wall Installation Example



*Courtesy of AAMA



Unitized/Panelized System



Example of Panel Assemblage



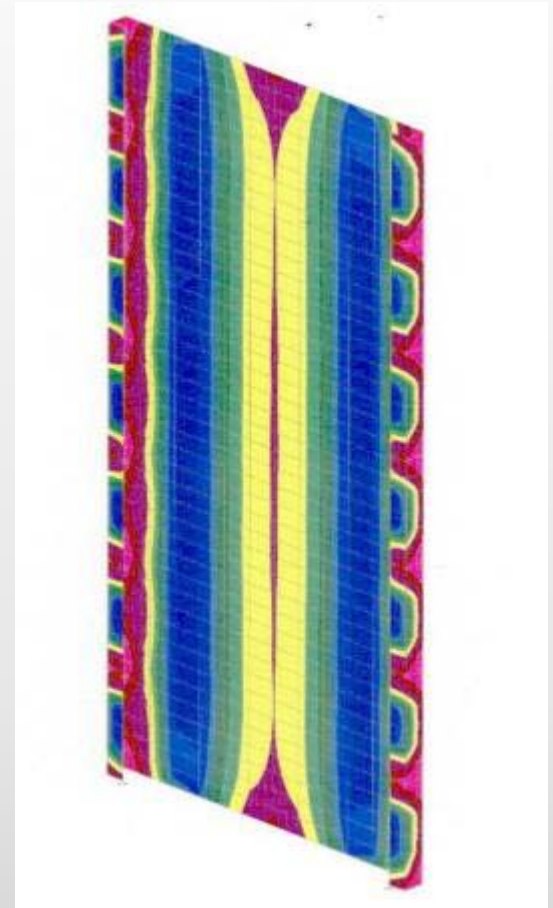
* Courtesy of Old Castle Glass



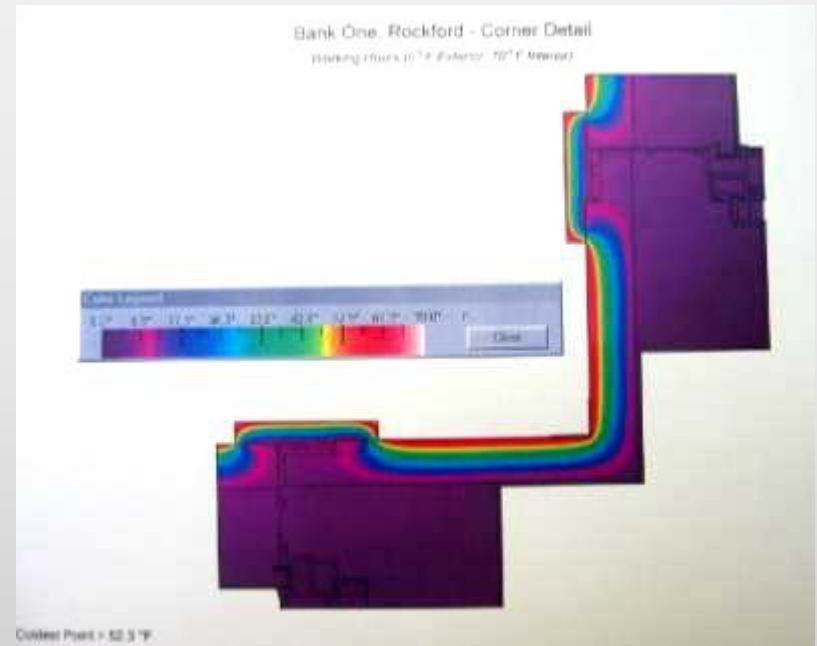
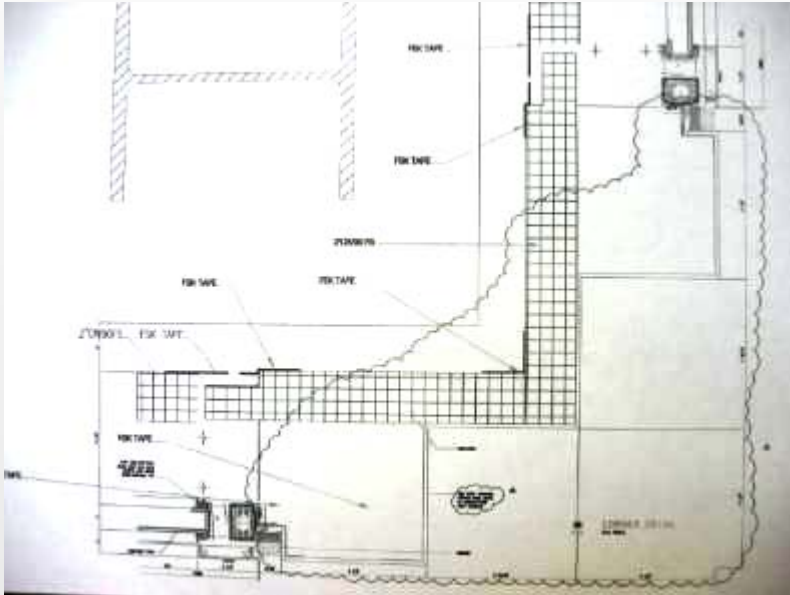
Curtain Wall Design Methodology

ANALYSIS

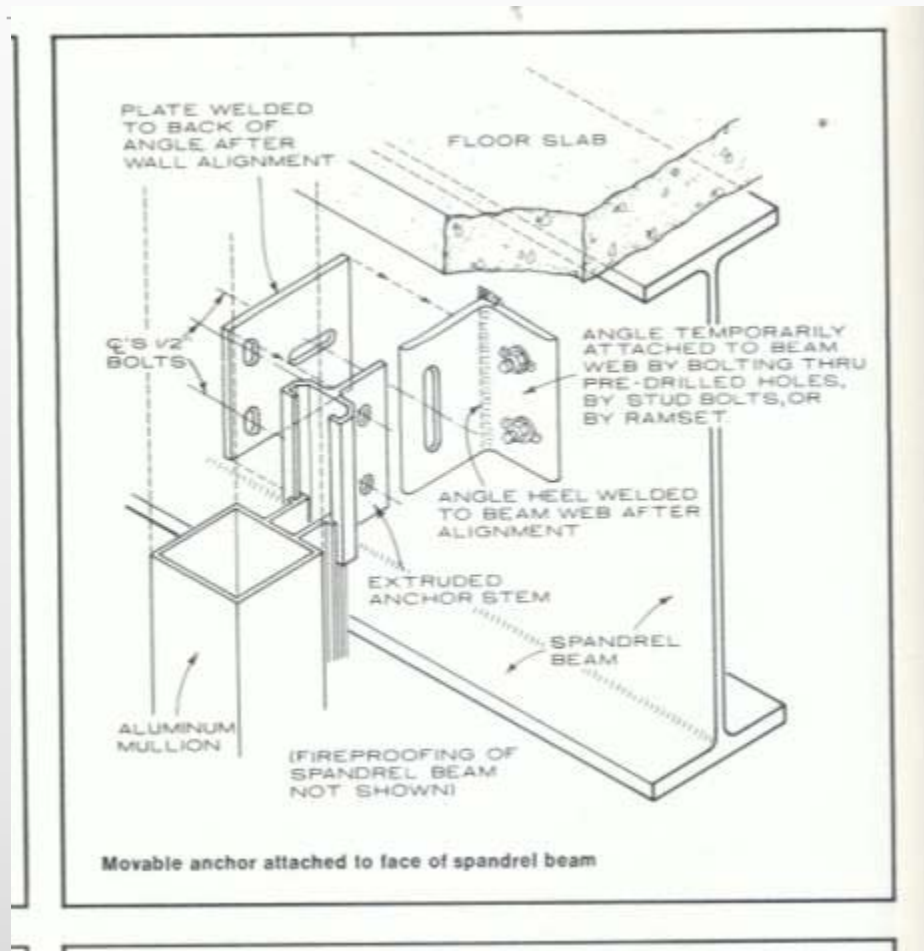
- **Stress Analysis**
- **Finite Element Analysis**
- **Dynamic Analysis (Blast)**
- **Wind Tunnel Study**
- **Testing**
- **Fracture Mechanics**



Thermal Simulation Test



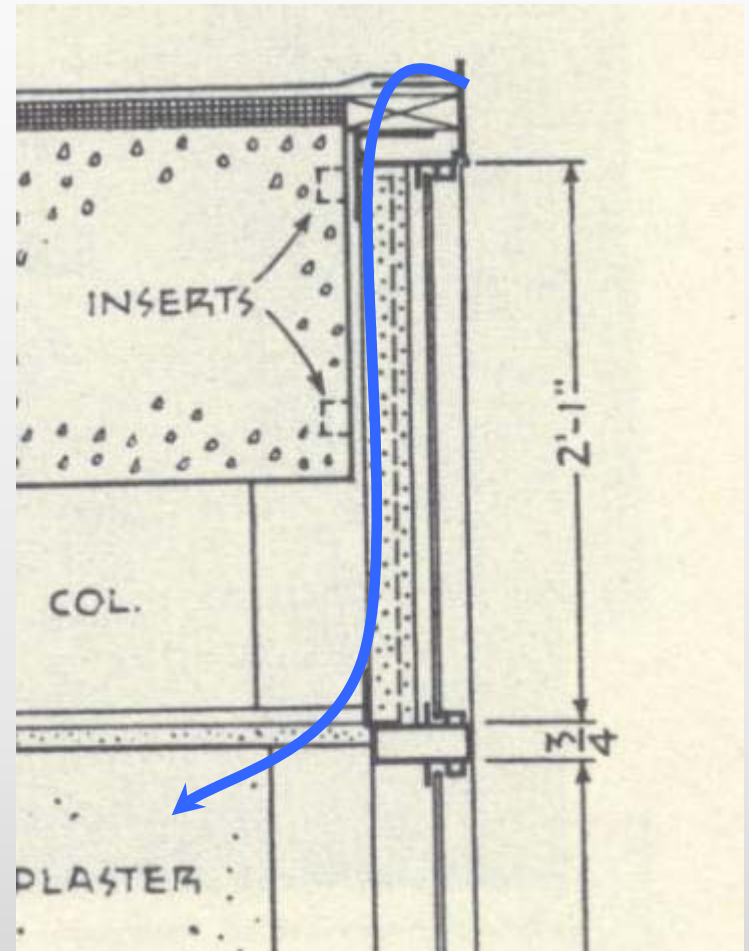
Forces and Movement



Anchors Must Accommodate Movement

Water Infiltration Concerns

- Need to control water infiltration
- Affect the mechanical load for controlling humidity
- Similar for air



Key Curtain Wall Components Related to Energy

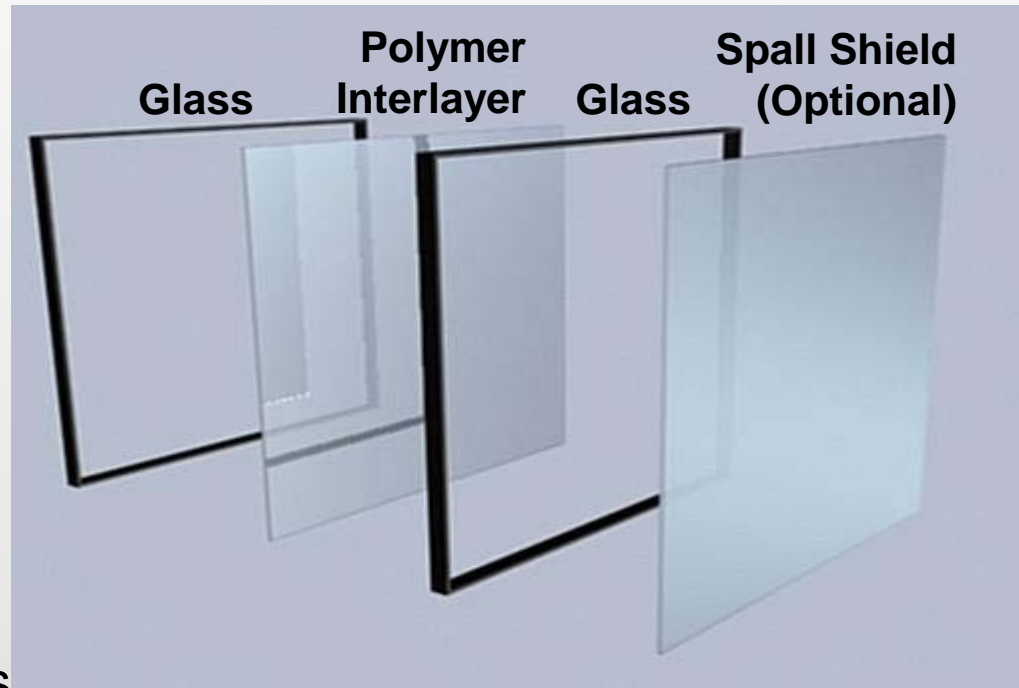
- Glazing
- Gaskets
- Sealants
- Framing
- Shading

Types of Glass

- Annealed
- Heat Strengthened
- Tempered

UNITS

- Monolithic Glazing
 - Least efficient
- IG Unit
 - More efficient
- Laminated Unit
 - interlayer added to retain glass



Glazing

MONOLITHIC GLAZING

- Some older buildings have monolithic glass which is not energy efficient
- Often these lites are not tinted for clearer visibility

➤ INSULATING GLAZING UNITS

- Widely used and effective with tint on the #2 surface to reduce the UV light.
- Flexibility to incorporate different glass combinations to make a unit (ex. Monolithic w/ laminated)



Glazing Remediation

MONOLITHIC GLAZING

- If no elements can be removed, consider the usage of Solar Films
- Reduces the level of UV through the fenestration.
- Replace Monolithic with IG Units where possible.

➤ INSULATING GLAZING UNITS

- Good option to improve performance by adding tint on the #2 surface to reduce the UV light.
 - The tint is protected and multiple color options.
 - Technology continues to improve and higher performance on glazing units are achieved.
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Gaskets

- Used as insulators and bearing surfaces for glazing
- Gaskets made from rubber and can be extruded.



Gasket Problems

AGED PERIMETER GASKETS

- Need to be replaced
- Poor air and water infiltration control



- Age sometimes cause shrinkage



Gasket Remediation

REPLACEMENT OPTIONS

- PRE-MOLDED GASKETS
- SEALANT “wet seal” APPROACH (EXTERIOR).



Sealants

- EXTERIOR APPLIED @ Perimeter Joints
- INTERIOR APPLIED @ Structural Glazing
@ Frame Connectivity

REMEDICATION

- Sealant Replacement
- “Wet” Seal application on glazing
at glazing perimeter.



Framing

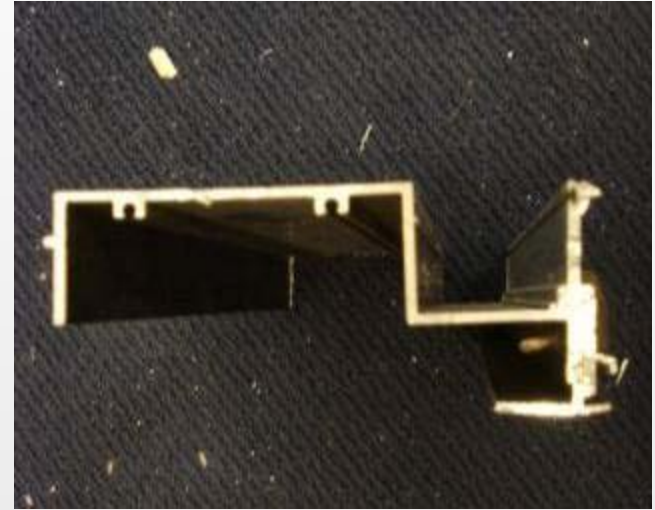
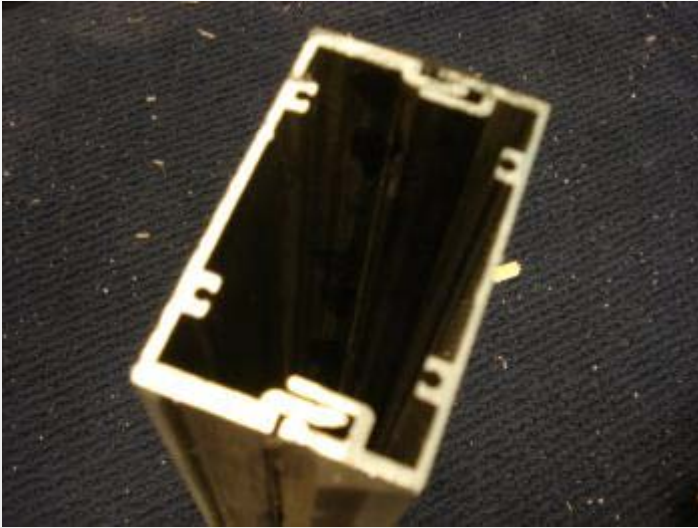
- Difficult to adjust for existing framing
- If framing is being removed, system type must be identified.

REMEDICATION

- Replacement has options : siteline, depth, type
 - New systems have thermal improvement with “thermal improved” or “thermal bridge” components
 - The rear frame is thermally isolated from the pressure cap.
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Framing



- Aluminum extrusions allow a lot of flexibility in adaptation to systems.
- Appendages can be added
- Challenging in existing conditions



Sunshades

- Offers Aesthetic Quality
- Offers energy relief to glazing
- Can be retrofitted on existing framing
- Dependent on the spandrel condition; glazing, stone, precast or metal panels.
- Connections have to be ideally co-ordinated thru caulk joints and waterproofed.



Sunshades

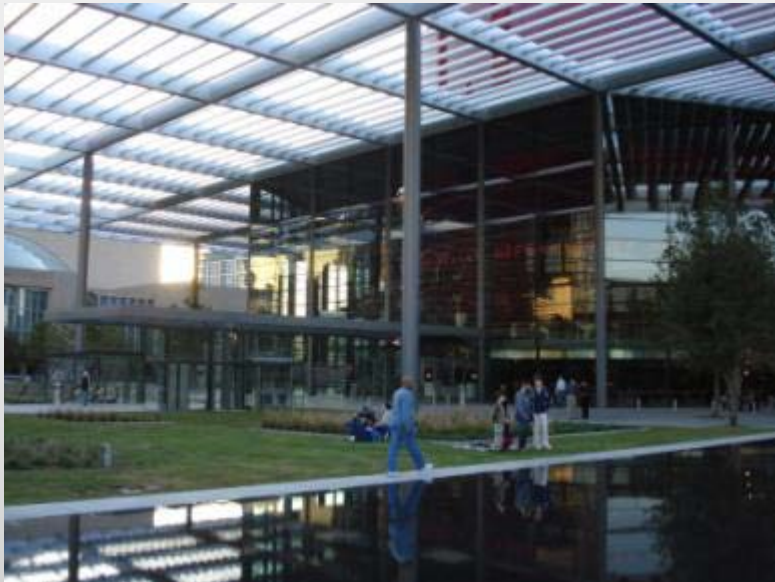


- Note the shading effect of the sunshade on the glazing
- Aesthetics are very important

- Zoom of the shading concept

Courtesy : Corgan





Larger scale shading




Exterior Façade Retrofit Example #1

High Rise Building in the SW

- Working with interior access
- Option to replace frames
- Option to upgrade elements



Exterior Cladding Retrofit Restraints

- Tight Project site
 - Aggressive schedule
 - Existing building shell
 - Atypical Openings
-
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Existing Conditions

- Loss of Glass at of Tower
- Heavy glass damage
- Temp Closure plates inserted



Existing Conditions



- Loss of Glass at of Tower



Lower Sloped Section
with loss of glass



Existing Conditions



- Interior Column grid at Lower Section ~ glazing removed.



Monolithic Glass



Existing Conditions



- Monolithic Glass ~ Full Height
 - Access at the floor
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Existing Conditions



- Existing shallow installed frames.



Monolithic Glazing



Exterior Façade Retrofit Punched Windows



- Tower Crane hoisting packaged frames to floors.



- Bundled Frames located on Floors



Exterior Façade Retrofit Punched Windows



- Installing new Punch Windows with high performance IG Units
 - Individual openings measured.
 - View from exterior of glazed openings
 - Note the tint on the glazing to reduce UV transmittance
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Exterior Façade Retrofit Punched Windows



- Operable windows at balconies – option for energy savings and ventilation.
- Door and windows sitting on a curb – mitigate water infiltration at sill



- Swing-out window in some punched openings
- Ventilation and energy savings option.

Exterior Façade Retrofit Unitized Curtain Wall



- Installing new Curtain wall
- Utilizing the existing building structure framing
- Unitized system~ Inside Set
- Note the tinted glazing



- View from exterior

Exterior Façade Retrofit Unitized Curtain Wall



- Interlocking Frames and Gaskets (Air/water control)



Custom Bayonet Anchor – flexible on modules.

Exterior Façade Retrofit Installation



- Setting from inside allowed flexibility of working anywhere on the building
 - Curtain wall and punched window set individually
 - Exterior swing stages are other trades.
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Transformed Tower



Credit: Corgan



Exterior Façade Retrofit



OLD FAÇADE -
OFFICE BLDG



NEW FAÇADE –
CONDOMINIUMS/RETAIL

Exterior Façade Retrofit



- ❖ Architectural Creativity.
- ❖ Upper Tower converted into Condos.
- ❖ Lower Section converted into Retail Space.
- ❖ Much improved energy consumption
- ❖ Limestone clad base.
- ❖ . Well received by the community.

Exterior Façade Retrofit Example #2



Credit : Gensler



- Example of retrofit on existing façade in-place
- Introduction of efficient glazing
- Introduction of sunshade features



Exterior Façade Retrofit Example #3



- Small openings
- Heavy façade
- Aesthetically dated for location



- More light introduced to opening
- Improved aesthetics
- Improved glazing performance

* Courtesy of Trainor Glass



Exterior Façade Retrofit Example #3



New building structure is being installed to create new space where the old building was, as well as tying in the façade type of the adjacent face to the area above the renovated floors.

* Courtesy of Trainor Glass

Summary

- Existing buildings present unique challenges
- Very dependent on the owners objectives
- Major retrofit working with framing removal should utilize a “design team” approach.
- Minor retrofit requires some level of inspection and guidance from a professional.



Summary (cont)

- Careful planning and staging is critical with relation to budgets and schemes.
 - Technology advancements should be utilized where feasible
 - Primary elements related to energy : glazing, gaskets, framing and sealant performance.
 - Accent elements such as sunshades can be introduced but detailing the interface requires co-ordination and design.
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Summary (cont)

- Typically there is an opportunity to effectively change an appearance of a building while upgrading energy efficiency.



Potential Retrofit for Energy

- Glazing replacement
- Framing replacement
- Framing Overclad
- Gasket replacement
- Sealant Replacement (Perimeter and “wet seal”)
- Sunshade elements
- Option for aesthetic upgrade while upgrading energy efficiency.



Aesthetics

- Very important element of the process
- Typically there is an opportunity to effectively change an appearance of a building while upgrading energy efficiency.



Potential Benefits

- Energy reduction
- Improved air / water control
- Improve building appearance while upgrading energy efficiency.
- Potential to incorporate material with improved technology and sustainability.



Thank You

Questions?

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