Building Envelope Study

Introduction

The building envelope of the Odyssey contains full height curtain walls sections matched with a brick veneer and punch window scheme. Curtain walls were added to the design early in the design phase when Monument Realty upgraded the building status from apartments to luxury condominiums. The curtain walls are a prestigious architectural feature of the prominent East face of the building overlooking downtown Arlington and the Washington Mall. The picture below shows the East elevation with the curtain walls and the brick veneer with punch windows on the remaining elevations.

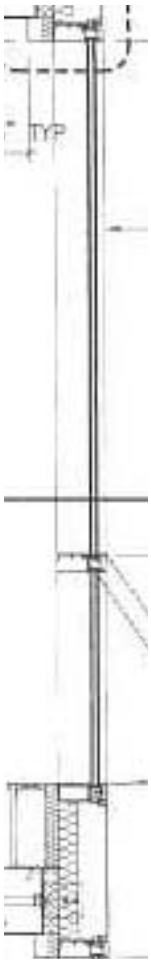
East Elevation

Design Criteria

The objective of the building envelope breadth study was evaluating the thermal efficiency of each design. A comparison between the systems would determine if the curtain wall is a reasonable design to maintain the thermal integrity of the envelope. Thermal properties of each typical wall section were selected in accordance with design specifications of ASHRAE Fundamentals 2001. Each wall assembly will be simulated in conditioned spaces with identical design criteria. The control space will alleviate any mechanical system discrepancies and allow for the direct observation and comparison between the thermal efficiencies of the envelope designs.

Curtain Wall Assembly

The curtain wall is the series 5900 Outside Glazed Curtain Wall System product of the EFCO Corporation. The overall system depth is 8"measured from the face of the aluminum mullions. The curtain wall is glazed with a 1" glass unit composed of interior 1/4" clear annealed glass with a low-emissivity soft coat, a 1/2" air space, and exterior 1/4" clear annealed glass. The curtain walls are thermally improved using EPDM gasket at the glazing interface to isolate exterior and interior air extrusions. The gasket is shown below in a vertical mullion section. The thermal resistance (R) and total calculated thermal transmittances (U) are listed below for the wall component and curtain wall system. A section of the curtain wall assembly is shown to the right with the wall component located at the bottom of the wall assembly.



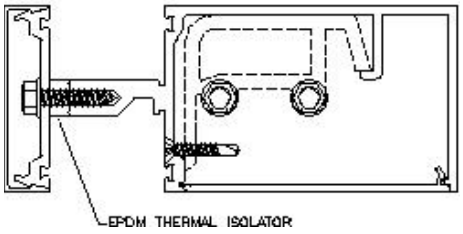
Curtain Wall Assembly

Wall Componet	thickness (in)	Resistance (R) (h ft^2 °F/ BTU)
Outside Surface		0.17
15 mph		
Ext Metal Panel	-	Negl.
med. wt. - 125pcf		
Air Space	3 1/2"	1.78
ε_{eff} = 0.25 (metal, batt)		
μ_{temp} = 50°F ΔT = 30°F		
vertical position		
Batt Insulation	2 1/2"	8
Vapor Seal	-	Negl.
Fire Cont. Insulation	1 1/2"	Negl.
Metal Stud Backup	2 1/2"	Negl.
Int. Gyp Board	1/2"	0.45
Inside Surface		0.685
Still air		

Resistance	ΣR = 11.1
U-Factor	U = 0.0902

Outside Glazed Curtain Wall System
EFCO Series 5900 - Thermal

U = 0.47



Brick Veneer / Window Assembly

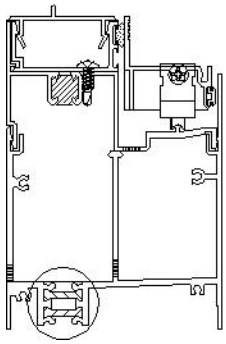
The standard building envelope has a 4" brick veneer with stud wall backup and horizontal sliding windows. The windows are series 3500 Thermal HS-AW50 Grade Horizontal Sliding Windows which are also a product of the EFCO Corporation. Thermal barriers in the heads, jambs, and sills are high density polyurethane and thermal struts consisting of glass reinforced polyamide nylon. Thermal strut locations in the sill are depicted in the mullion section below. The thermal resistance (R) and total calculated thermal transmittances (U) are listed below for the wall component and sliding windows. A typical section of the brick veneer and window assembly is shown to the right.

Brick Veneer / Window Assembly

Wall Componet	thickness (in)	Resistance (R) (h ft² °F/ BTU)
Outside Surface		0.17
15 mph		
Brick Veneer	4"	0.64
med. wt. - 125pcf		
Air Space	2 1/2"	0.9
ε_{eff} = 0.82 (masonry)		
μ_{temp} = 50°F ΔT = 30°F		
vertical position		
Vapor Seal	-	Negl.
Ext. Grade Sheating	5/8"	1.65
Metal Stud Backup	6"	Negl.
Batt Insulation	6"	19
Int. Gyp Board	1/2"	0.45
Inside Surface		0.685
Still air		

Resistance	ΣR = 23.5
U-Factor	U = 0.0426

Horizontal Sliding Windows
EFCO Series 3500 - Thermal — U = 0.56

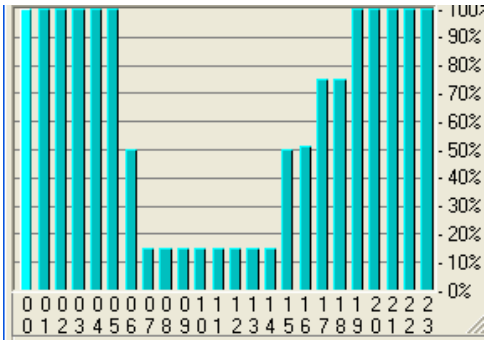


Thermal struts

Thermal Analysis

The building envelopes were modeled over a typical 421 ft^2 tributary area of the curtain wall system on the East elevation. The brick veneer and sliding window model contained 8 windows, each with a coverage area of 24 ft^2. The Carrier Hourly Analysis Program 4.2 (HAP) was used to simulate the thermal efficiencies of the walls with the assumed space criteria listed below.

- Gross Floor Area: 1250 ft^2
- Ceiling Height: 8'-8"
- Occupancy: 4
- Activity Level: Sedentary Work
- Lighting / Electrical 1 W/ft^2 / 5 W/ft^2
- Hourly Load Schedule →



I simulated a variable air volume (VAV) mechanical system instead of the individual heat pump systems used in the Odyssey. The alteration does not affect the efficiency study of the building envelopes. The calculated design heating and cooling loads will only be checked against each other for a comparative efficiency of the envelope systems and will not be regarded as the actual design loads for the space.

Conclusions

I calculated the efficiency of the curtain wall for envelope and space loads from the results of the HAP simulation. The thermal efficiencies of the curtain wall are listed to the right with an average loss of 18.5 % compared to the brick veneer and window assembly. These losses incur additional costs in the mechanical design requirements to maintain thermal control of the space. The curtain wall may add an architectural statement to the building envelope; however it will not maintain a reasonable thermal integrity with the remaining building envelope.

Envelope Loads:

Cooling Transmission (BTU/hr)	**- 20.0 %**
Heating Transmission (BTU/hr)	**- 22.4 %**

Space Loads:

Cooling Load (MBH)	**- 9.30 %**
Heating Load (MBH)	**- 22.6 %**