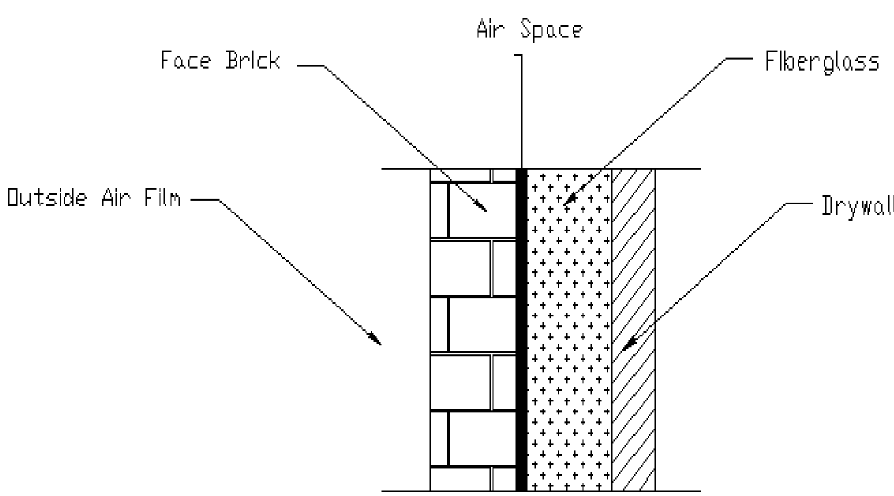
Analysis 2: HVAC System Reduction (Breadth Study)

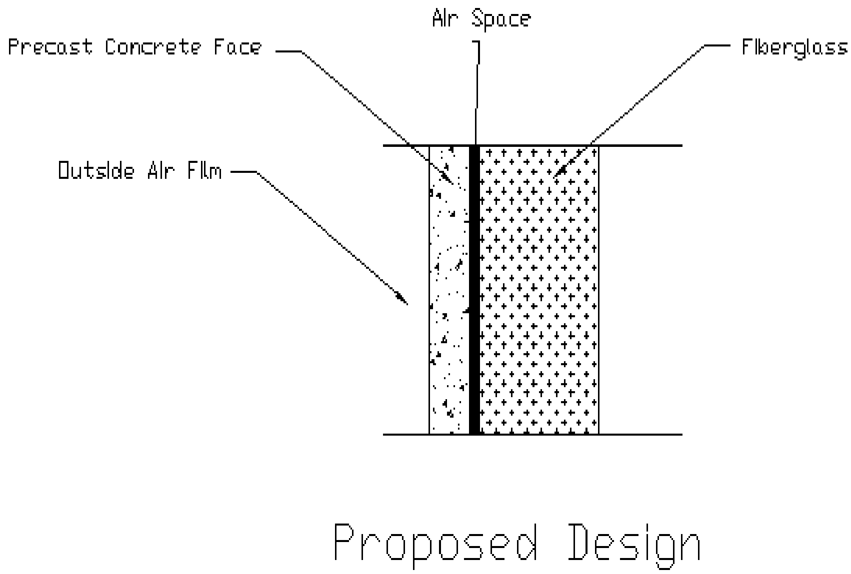
The new Slendelwall System does no only contribute to the project by reducing the duration of the project, but also it insulates the building better. The Slenderwall panels have a 1/2-inch air space between the concrete panel and stud, and the exclusive epoxy-coated stainless-steel Nelson® anchor that prevents corrosion and reduces thermal transfer by as much as 25%. The additional insulation reduces heating and cooling costs.

This analysis investigates the effects of the additional insulation on energy savings and the effects on the HVAC system in terms of cost savings. The additional insulation of the exterior wall could potentially save cost by downsizing some of the HVAC equipment used in the building.

Impacts to the mechanical system were analyzed by first calculating the R-Values for each system. The original brick assembly included a 4” thick face brick, 1” air space, and 1” thick extruded polystyrene rigid insulation. The Slenderwall System includes a 2” thick architectural concrete layer, ½” air space, and 6” steel frame supports filled with fiberglass batt insulation. The R- Values demonstrated that the Slenderwall® will reduce the thermal conductivity significantly. Impacts to the mechanical system will be studied on the next section of this analysis. Sections of both systems as well as the R-Values calculation are shown below.



Existing Design



Current Brick assembly R-Values

Layer	Thickness	R-Value/inch	Total R-Value
Unit	(in)		(hr-SF-F/BTU)
Outside Air Film	∞	0.17	0.17
Brick	4	.8/thickness	0.8
Drywall	2	0.9	1.8
Air Space	0.5	1	0.5
Fiberglass	4	3.2	12.8
			16.07

SlenderWall System R-Values

Layer	Thickness	R-Value/inch	Total R-Value
Unit	(in)		(hr-SF-F/BTU)
Outside Air Film	∞	0.17	0.17
Precast Concrete face	2	0.8	1.6
Air Space	0.5	1	0.5
Fiberglass Batt insulation	6	3.14	18.84
			21.1

R-Values and U-Value

System	R-Value	U-Value
Unit	hr-SF-F/BTU	BTU/hr-SF-F
Current Brick system	16.07	.0622
SlenderWall System	21.1	.0474

Load Analysis

	Area (SF)
Perimeter Wall	65,000

Winter Temperature In Washington DC	
To	15°F
Ti	70°F
Change in Temperature	55°F

Summer Temperature In Washington DC	
To	95°F
Ti	70°F
Change in Temperature	25°F

Heat Loss During Winter				
System	U-Value (BTU/hr-sf-F)	Area (SF)	Δ T (F)	Heat Loss (BTU/hr)
Current Brick Façade	.0622	65,000	55°F	222,365
SlenderWall System	.0474	65,000	55°F	169,455
			Difference	**52,910**

Heat Gain During Summer				
System	U-Value (BTU/hr-sf-F)	Area (SF)	Δ T (F)	Heat Loss (BTU/hr)
Current Brick Façade	.0622	65,000	25°F	101,075
SlenderWall System	.0474	65,000	25°F	77,025
			Difference	**24,050**

With the SlennderWall system, The HVAC system would have to provide 52,910 BTU/Hr less in the winter and 24,050 BTU/Hr less in the summer. Since the HVAC system would have to deliver less BTU/Hr, there is the possibility that it can be downsized. The purpose of reducing the HVAC system is that it would decrease the costs of electricity and increase energy savings. The savings would be noticeable right away, and in the long run as well. The possibility of downsizing the HVAC system to reduce costs will be studied on the next section.

Current Mechanical System

The mechanical system consists on three rooftop units, and two air-handling units located on the first floor that serves the retail stores, restaurants, and the parking garage. The HVAC system for the residential part consists on individual HVAC units for each apartment. The mechanical system contains thirteen different types of pumps. It has two 400 ton chillers and two 1200 GPM 400 ton cooling towers. The air is distributed through galvanizes steel ducts that run all throughout the building. The building has a wet pipe sprinkler system. Smoke detectors as well as sprinklers are located all throughout the building.

For this analysis, I will only focus on the reduction of the HVAC system serving the residential part. Since each apartment has its own HVAC unit, I wanted to see if with the additional insulation of the building, provided by the Slenderwall panels, I could reduce the number of HVAC units in the building. Maybe some apartment could now share a HVAC unit. In the entire building, there are 180 apartments; 53 in the second floor, 35 on the third, 57 on the fourth, and 35 apartments on the fifth floor. The HVAC unit used on each apartment is a WY13B33A 12,500 BTU/Hr Friedrich Cooling/Heat Pump Air Conditioner.

Cooling Capacity: 12,500/12,100 BTU/h

Heating Capacity: 10,400/10,000 BTU/h

EER: 9.0/9.0

Moisture Removal: 3.2 Pints/Hr.

Room Side Air Circulation: 280 CFM

Volts Rated: 230/208

Cooling Amps: 6.4/6.8

Cooling Watts: 1,389/1,352

Heating Amps: 5.4/5.7

Heating Watts: 1,182/1,136

The Most Energy Efficient Solid-side Air Conditioner

° High efficiency operation saves on energy costs
° Residential/ commercial application
° Mounts flush with the exterior wall for a neat appearance
° Ideal for thicker wall installations, where side fins don't fit
° Exact fit for Fedders A and B sleeves. Sleeves measures 27" W x 16 3/4" H
° Easy-to-reach, top mount controls
° Three-speed fan
° Magna 1 copper coils
° Efficient rotary compressor
° Easy-to-clean filter

Mechanical System Impacts

The implementation of the Slenderwall system reduced the amount of BTU/Hr needed. My intention was to reduce the BTU/Hr necessity so that some HVAC units could be downsized. The approximate cost of each unit is $1000. There are 180 units in the building meaning that $180,000 was spent on the residential HVAC individual units.

There were three approached that I could have taken. The first one was to eliminate as many HVAC units as possible considering the reduction of BTU/Hr needed. The second approach was switch to a central HVAC system that served the entire space. The third option was to divide the BTU/Hr that are not needed anymore into each unit. That way the BTU/Hr needed on each apartment would be reduced, and therefore the HVAC individual units could be downsized.

After analyzing all options, I realized that neither one really works. Taking in account the summer and winter, which are the season that people will need the HVAC units the most, the Slenderwall system would only eliminate two to four units. That would mean that only $4,000 would be saved. Moreover this approach would not have worked anyways since each apartment needs one unit. Four thousand dollar is not a significant amount and therefore the idea of eliminating some individual units is not really a good option.

The second option of implementing a central HVAC system was not a good idea either since the entire structure would have to be redesigned. A central HVAC system is not necessarily cheaper since there is the need of installing ductwork. In the end, the individual units work bets for this project.

The Third option did not work either. With the slenderwall system, each apartment would need 294 BTU/Hr less in the winter and 134 BTU/Hr less in the summer. The current individual HVAC units have a cooling capacity of 12,500 BTU/Hr and a heating capacity of 10,400 BTU/Hr. The table below shows some other individual HVAC units that provide less heating and cooling tons. The current units are model WY13B33A. If we were to downsize the individual units, the next model on the list is WY10B33A. This unit has a cooling capacity of 10,100 BTU/Hr and a heating capacity of 10,400 BTU/Hr. The reduction of BTU/Hr needed on each apartment due to the Slenderwall system is not enough to downsize the individual units.

Model	Cooling BTU/h	Heating BTU/h	Volts	Amps**	EER	Height in.	Width in.	Depth in.	Circuit Breaker	Weight lbs.
WS08B10A	8000		115	6.8	10.5	16-3/4	27	16-3/4	125V-15A	93
WS10B10A	10000		115	8.7	10.5	16-3/4	27	16-3/4	125V-15A	103
WS14B10A	13500		115	12.0	9.5	16-3/4	27	16-3/4	125V-15A	112
WS10B30A	10000		230/208	4.6/5.0	10.0	16-3/4	27	16-3/4	250V-15A	101
WS13B30B	12500		230/208	6.3/6.7	8.9	16-3/4	27	16-3/4	250V-15A	109
WS16B30A	15800		230/208	7.8/8.5	9.0	16-3/4	27	16-3/4	250V-15A	119
WE10B33A	10000	11000	230/208	16.0/14.7	10.0	16-3/4	27	16-3/4	250V-20A	103
WE13B33B	12500	11000	230/208	16.0/14.7	8.9	16-3/4	27	16-3/4	250V-20A	111
WE16B33A	15800	11000	230/208	16.0/14.7	9.0	16-3/4	27	16-3/4	250V-20A	121
WY10B33A	10100	8100*	230/208	3.9/6.0	10.0	16-3/4	27	16-3/4	250V-20A	107
WY13B33A	12500	10400*	230/208	5.4/5.7	9.0	16-3/4	27	16-3/4	250V-20A	116

Conclusion

After analyzing the data and studying the different possibilities, I came to the conclusion that even thought the Slenderwall panel system provides greater insulation to the building, the HVAC system is not really affected by it. The precast system does have many advantages that where pointed out on the first analysis. However, the HVAC system is not really beneficed by it. Maybe if the HVAC system for the residential area would be a central system, then maybe downsizing the system would have been possible. However, since the HVAC system serving the residential area are individual units for each apartment, then the precast system does not help at all, and the system has remain the same. The only advantage that the precast panels would provide to the mechanical system is that with the additional insulation, electricity costs would decrease since heat loss through the walls would decrease.