

## **Analysis 1: Alternative Building Envelope**

### **Issue 1:**

Plaza's East building envelope uses architectural precast concrete which had difficulty matching colors and problems with glazing leaks. If a different building envelope was used, there would be less load put on the superstructure and energy could be saved through different building envelope panels.

### **Analysis:**

Research will be done on cost, schedule impacts, energy savings, and quality. Contacts will be made with a different subcontractor(s) to compare separate panel systems. Transportation cost could differ depending on where each envelope came from. If the architectural precast is no longer used, there will be no more problems with the color matching of the precast. The precast also came from Canada which contributed to long drives to transport the panels. With no precast panels the erection time can be higher and the crane picks could be smaller. Each of these aspects can change the amount of labor needed on the job. If time permits, a change in the curtain wall glass will also be looked into. This can also save on heating and cooling of the building, adding to energy savings.

### **Expectations:**

After detailed research and analysis of at least two alternate building envelope methods one will be recommended to save on cost, labor, and energy efficiency. With this suggestion incorporated, the money saved can go to other aspects of the building. The money saved is expected to come from the less expensive material, quicker erection time, and energy saving costs.

## Outcome:

After creating a few questions about the current precast system, I came in contact with John Myers, Director of Technical Services of Harmon Inc. I wanted to see if there was a more economical or environmentally safer direction the envelope could lean towards. He answered the questions I had given to him pertaining to my building envelop analysis.

John began with the cost benefits of the current building envelope. The benefits are pretty vague because the final installed cost of precast panels are affected by multiple things including means of panelization, access to the structure, finishes, repetition, and availability. Advantages of precast can come from its durability from impact and blast mitigation, good acoustic performance due to density, and the repetitive details such as rustications, accent features, and articulation generated in a single mold can be replicated.

When using precast you must also have to accept the bad with the good. The calcium carbonate matrix of precast is subject to degradation from acid rain and the alkali runoff etches glass and deteriorates metal. This is something Plaza East contractors must worry about considering the glass panels and aluminum mullions. Surface finishes are limited with precast and are inconsistent. Plaza East had this exact problem and had to scrub the building exterior to shade the colors better together. Precast can be very heavy and the weight can be a problem when it comes to the erection. Some of the larger pieces used on the Plaza East project were up to 20 tons, this alone calls for a larger crane, raising equipment costs. The sealant joints rely on field applied materials and the suspect quality of the bond line surface. The laborers must be careful when putting on every sealant to be sure of clean areas and proper bonding, Laborer safety should also be a concern. Mr. Myer concluded that safety is always on people's minds, but a precast erection accident is often fatal.

After having a general look at the precast curtain wall, I wanted some ideas of what to replace it with. Mr. Myers gave a few suggestions:

- GFRC, Glass Fiber reinforced concrete

- At 5/8" thickness and mounted on a steel framework, GFRC provides the durability but is lighter and allows the insulation to occur further toward the exterior envelope.
- EIFS, Dryvit
  - Although sadly lacking durability, with light weight construction a wide variety of aesthetics can be achieved.
- Centria Duracast Dimension Series Panels
  - A light weight foam core steel skinned panel system that provides an encapsulated temperature gradient and was designed to replace limestone and precast. Its non directional embossed panels, with a beige finish, also approximate a precast finish.

Myers finished saying other metal panel, ceramic and GRFP systems have been used to replace precast although they may have a different surface texture.

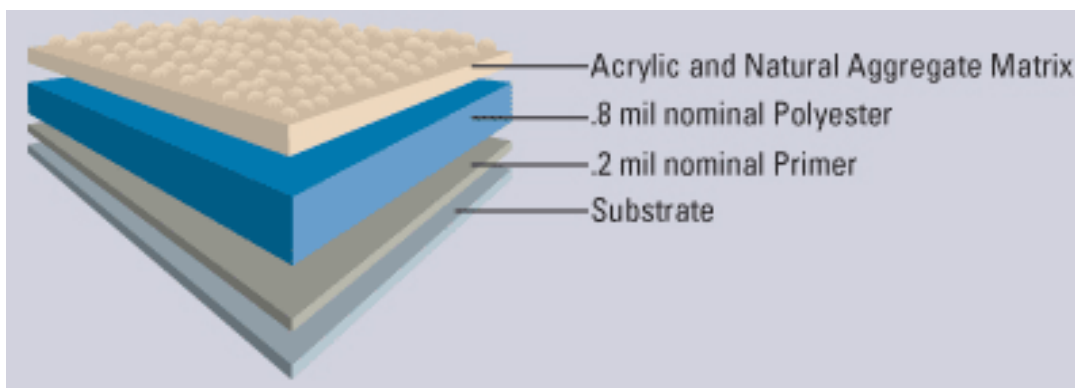
Along with new materials to replace the precast panels, some ideas were given for new glass and glazing products. A few suggestions included adding coatings to provide better shading coefficients and low emissivity such as:

- Viracon VE1-2M or Viracon's VRE and VNE coatings
- PPG's Solarban 60 or 70
- Glass Sage Electrochromics
- BIPV (building integrated photovoltaic) this would typically change the façade to maximize the benefits and optimize solar exposure to the panels.

After further investigation I thought of comparing an EIFS system to the precast concrete. After consulting Pete Clark, an assistant project manager on the job, Felix Tansil, Tishman Speyer representative, and John Myers, this choice proved to be not as good as the

precast concrete envelope. Mr. Tansil and Mr. Myers told me Tishman Speyer, the owner, nor HOK, the architect would accept EIFS as a cladding material. Both firms understand the limited life expectancy and the common poor quality of EIFS installation. Tishman usually keeps their properties and are not interested in the initial cost savings at the risk of low performance. Mr. Myers also said EIFS does not allow water infiltration and is typically flashed poorly. Degradation of the supporting stud work would be catastrophic and even window washing rigs will severely damage the surface. Mr. Tansil of Tishman Speyer also assured me when accenting the facade; they like to reduce maintenance and operational cost. The precast concrete's durability does that. So after that short conversation EIFS seems to be out of the picture.

The next choice I wanted to look into was the CENTRIA Duracast. The Duracast finish is a shop-applied 100% acrylic coating including silica aggregate that provides the look and feel of precast with an insulated metal panel (**Fig 3**). Compared to precast, Duracast reduces structural requirements and installation costs, eliminates most sealants that degrade and stain from dry seal joinery, shortens material lead times, and has faster installation. It comes in 8 colors, or custom colors can be made. Duracast is fully tested to ensure long service life.



**Fig 3**

The first type of panel I looked into was the Versawall panels. Looking into appearance and the size of these panels, I don't feel this material could give Plaza East the same look it has with the thick pieces of precast. The thickest Versawall panel had a 4" depth, a 36" width, and a 40' length. Unless you consult CENTRIA for longer lengths, just by sheer dimensions these panels could not resemble the original design. Although this is the case, I wanted to see if it

would be cheaper and more energy efficient if used. The R value for a 4" piece was R30.2. Another aspect to be aware of is that these foam filled metal panels can look like concrete, because of the Duracast coat, but are better for the environment than concrete. These panels can receive LEED points up to 10 for optimizing energy performance, 2 for recycling content, and 2 for low-emitting materials (Adhesives and Sealants, Paints and Coatings).

The second type of panel looked into was the Formawall Dimension Series panels, which was an original suggestion from Mr. Myers. Researching appearance and the size of these panels prove the same findings as the Versawall panels. They have the same dimensions, but similar to the Versawall, they look extremely different than the architectural precast façade. The R Value for these panels is a little less than the Versawall at R20. Similar to the Versawall these panels also look like concrete (Duracast) but are still better for the environment. These panels also can receive LEED points up to 2 for recycled content, 1 for regional materials, 2 for low-emitting materials (Adhesives and Sealants, Paints and Coatings), and 10 for optimizing energy performance.

I contacted Benjamin W. Marnik, a P.E. at CENTRIA. He began by informing me my application is not typical for Versawalls. To achieve the level of detail Plaza East shows, a more appropriate material would be CENTRIA Formwall Dimension Series, as stated before by Mr. John Myers from Harmon Inc. The information on the Versawall is as follows: 2.6 psf for 26 Ga. Skins and 3.7 psf for 22 Ga. Skins. He did not have an answer for how much quicker the wall would go up, but he assured it would be less time consuming. For pricing Mr. Marnik told me to use \$20/ft<sup>2</sup> to find a total cost and with that I should get a ballpark number. Keeping in mind this would have simple vertical panels, all the same module, with press broken flashing details. If using the Formwall Dimension Series the price per square foot would be doubled to \$40/ft<sup>2</sup>.

After speaking with Peter Clark from DAVIS Construction I was informed that CENTRIA has about only one or two contractors who are certified to apply their panels, which ends up increasing the prices. I was suggested to mark up the price about 50% and came to \$30/ft<sup>2</sup> for the Versawall and \$60/ft<sup>2</sup> for the Formwall (**Table 3 & 4**).

CENTRIA 4" Versawall with Duracast Finishing						
	Quantity	Unit	Mat. Cost	Inst. Cost	Total Unit Cost	Total Cost
North Elevation	6,240	sf	-	-	30.00	\$187,200.00
East Elevation	5,236	sf	-	-	30.00	\$157,080.00
South Elevation	7,413	sf	-	-	30.00	\$222,390.00
West Elevation	4,774	sf	-	-	30.00	\$143,220.00
<b>Total</b>	<b>23,663</b>	<b>sf</b>				<b>\$709,890.00</b>

**Table 3**

CENTRIA Formwall Dimension Series with Duracast Finishing						
	Quantity	Unit	Mat. Cost	Inst. Cost	Total Unit Cost	Total Cost
North Elevation	6,240	sf	-	-	60.00	\$374,400.00
East Elevation	5,236	sf	-	-	60.00	\$314,160.00
South Elevation	7,413	sf	-	-	60.00	\$444,780.00
West Elevation	4,774	sf	-	-	60.00	\$286,440.00
<b>Total</b>	<b>23,663</b>	<b>sf</b>				<b>\$1,419,780.00</b>

**Table 4**

Savings: 4" Versawall with Duracast Finishing  
 Actual precast cost (not including change orders):  
 $\$2,600,000.00 - \$709,890.00 = \mathbf{\$1,890,110.00}$

Formawall Dimension Series with Duracast Finishing  
 Actual precast cost (not including change orders):  
 $\$2,600,000.00 - \$1,419,780.00 = \mathbf{\$1,180,220.00}$

Looking into wall sections and areas, a few calculations were performed using Energy 10 to perform an energy saving cost analysis for the new envelope system. The Versawall panels seem to be by themselves with some sheathing, so I will choose a wall in the Energy 10 library near the R30 value given from the website. The Formwall Dimension Series has an R value of 20, so a wall system in Energy 10 resembling an R20 value was used. Keeping the windows the same I isolated the walls to see how much annual savings you could have.

When starting with Energy 10, I first put information into the ***New Project Information*** (Fig 4) box, which would closely match my building, into the system. Most of my original suggestions when importing information came from Andy Lau, who was well informed on how

Energy is to be used. I was suggested to break up my top floor into two zones, zone 1 the perimeter of the building 20' from the outside and zone 2, the remaining interior. This included:

- Location: Sterling, Virginia
- Utility Rates: (given by Tishman Speyer)
  - Elec. Rate: 0.35 \$/kWh
  - Elec. Demand: 0.30 \$/kW
  - Fuel Cost: 0.00 \$/Therm
- Zone 1 (perimeter):
  - Building Use: Office
  - HVAC System: VAV DX Cooling w/ Gas HW reheat
  - Floor Area: 11,840 ft<sup>2</sup>
  - # of Stories: 1
- Zone 2 (interior):
  - Building Use: Office
  - HVAC System: VAV DX Cooling w/ Gas HW reheat
  - Floor Area: 14221.8 ft<sup>2</sup>
  - # of Stories: 1
- Aspect Ratio: Long/Short side →  $214.5/121.5 = 1.765$

The screenshot shows a 'New Project Information' dialog box with the following fields and values:

- Location:** Weather File: STERLING.ET1, City: STERLING, State: VIRGINIA
- Utility Rates:** Elec Rate: 0.35 \$/kWh, Elec Demand: .3 \$/kW, Fuel Cost: 0 \$/Therm
- Zone 1:** Building Use: Office, HVAC System: VAV DX cooling w/ Gas HW rel, Floor Area: 11840 ft<sup>2</sup>, Number of Stories: 1
- Zone 2 (if applicable):** Building Use: Office, HVAC System: VAV DX cooling w/ Gas HW rel, Floor Area: 14221.8 ft<sup>2</sup>, Number of Stories: 1
- Shoebbox Geometry:** Aspect Ratio: 1.765, Library to use: ARCHIVELIB

Buttons include: OK, Cancel, Help, Inspect Building Use Defaults, Save As Default.

Fig 4

The next box was the **Provisional Data for Bldg-1 – Zone 1 (perimeter)** (Fig 5). Information added in this box included:

- Gross Dimensions:

North, South Facades:

Length and Height 214.5' x 12.5'

East, West Facades:

Length and Height 121.5' x 12.5'

Ceiling Area: 11,840 ft<sup>2</sup>

- Construction:

Roof Construction: flat, r-19 (was closest to drawings, r-18)

Wall Construction: Concrete (due to precast panels)

Floor Construction: Slab



- Windows (Number and Type):

When trying to create my own windows later in the process, the simulations did not seem to run without an error. So I took the square foot area of the 1" thick thermalite insulated low e and the ¼" reflective spandrel glass and added them up to get a total area of glass. Then I set it equal to a 6' x 6' double, low e window in the program, for each façade coming up with:

North: 43 windows

East: 20 windows

South: 37 windows

West: 22 windows

- Occupancy:

Number of People: 114 (when added to Zone 2 will equal 250 total, from drawings)

Open: 5 days

Lighting: 2 W/ft<sup>2</sup> (given by Tishman Speyer)

- Thermostat:

Set Point Heating: 72° and Cooling 75°

Schedule: 8 to 5

- Recommended to put Ducts Inside

- Rotated Building 30 degrees to match site placement of building 1

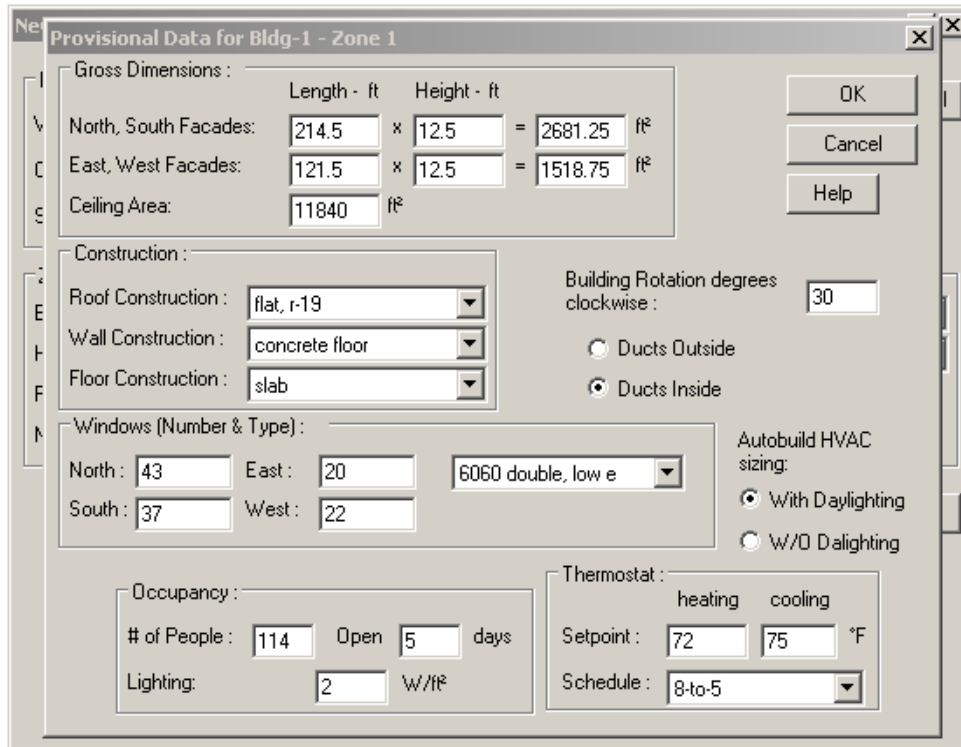


Fig 5

The next box was the ***Provisional Data for Bldg-1 – Zone 2 (Interior)*** (Fig 6). Information added in this box included:

- Gross Dimensions:
  - North, South Facades:
 

Length and Height	174.5' x 12.5'
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  - East, West Facades:
 

Length and Height	81.5' x 12.5'
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  - Ceiling Area: 14,221.8 ft<sup>2</sup>
- Construction:
  - Roof Construction: flat, r-19 (was closest to drawings, r-18)
  - Wall Construction: r1000 (no walls in interior zone)

Floor Construction: Slab

- Windows (Number and Type):

Zero windows for each face

- Occupancy:

Number of People: 136 (when added to Zone 1 will equal 250 total,  
from drawings)

Open: 5 days

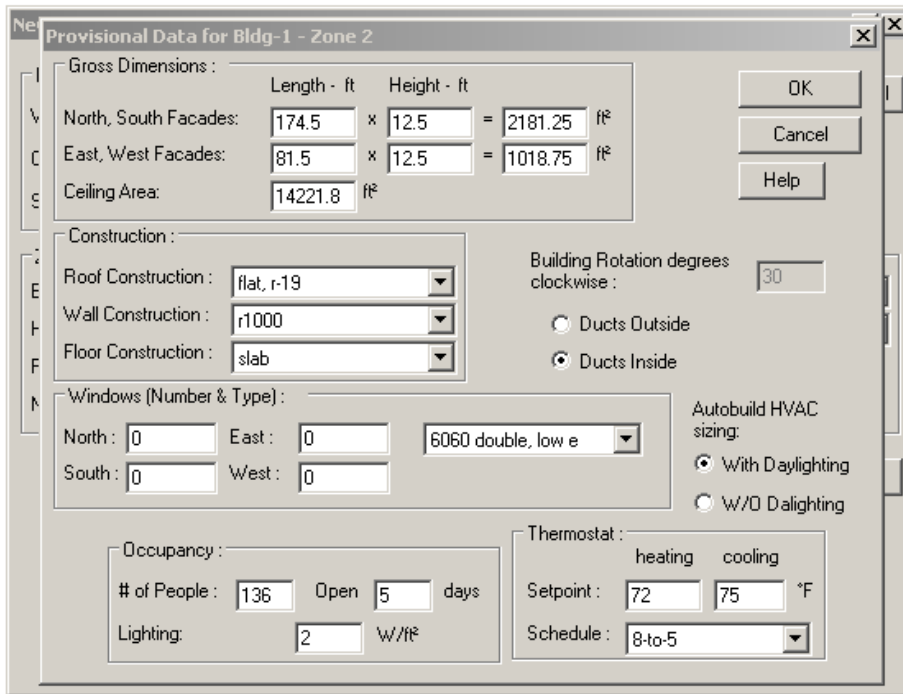
Lighting: 2 W/ft<sup>2</sup> (given by Tishman Speyer)

- Thermostat:

Set Point Heating: 72° and Cooling 75°

Schedule: 8 to 5

- Recommended to put Ducts Inside
- Rotated Building 30 degrees to match site placement of building 1



**Fig 6**

After this initial data is placed into Energy 10 you can begin to further detail your building by going into the buildings menu and choosing building 1 (**Fig 7**). This menu allows you to change walls, roofs, floors, partitions infiltration, HVAC systems, HVAC Controls, Internal Gains, and Lighting Zones. Leaving everything to default you can go into the Walls and roof button and change your windows and roofs, and window area.

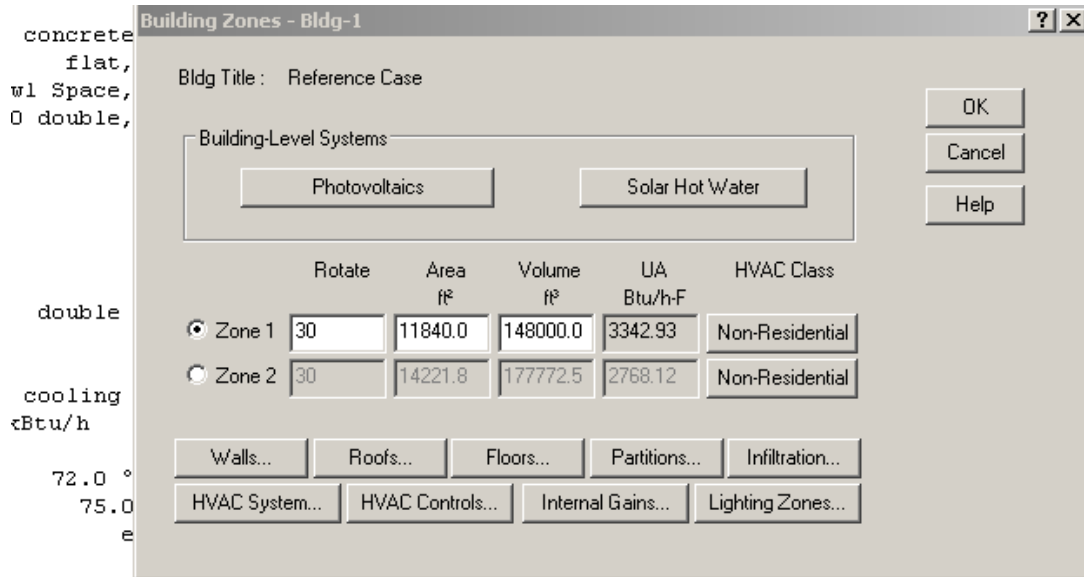


Fig 7

Clicking on the Walls button of Fig 7 you are brought to another menu, where changing your wall types becomes more detailed. You click on the little folder next to the name of one of your facades and it brings you to Fig 8. I created my own wall type for each façade called *arch conc panel*. This “wall” gave me an R Value of 10, which is exactly what the wall was said to have in the drawings. I only used one type of wall cross section at 100% because the precast panels are all we are looking at. After changing the name and information you can click on the “New” button and this will now be an option for all the other walls as seen on Fig 9.

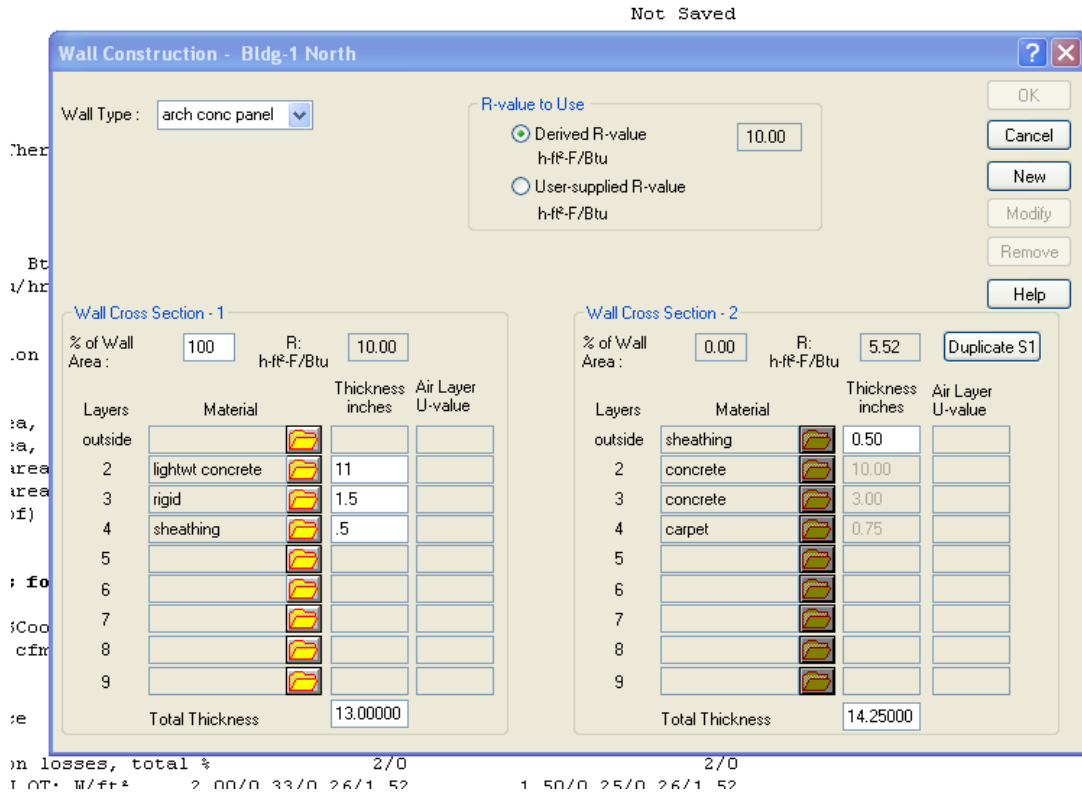


Fig 8

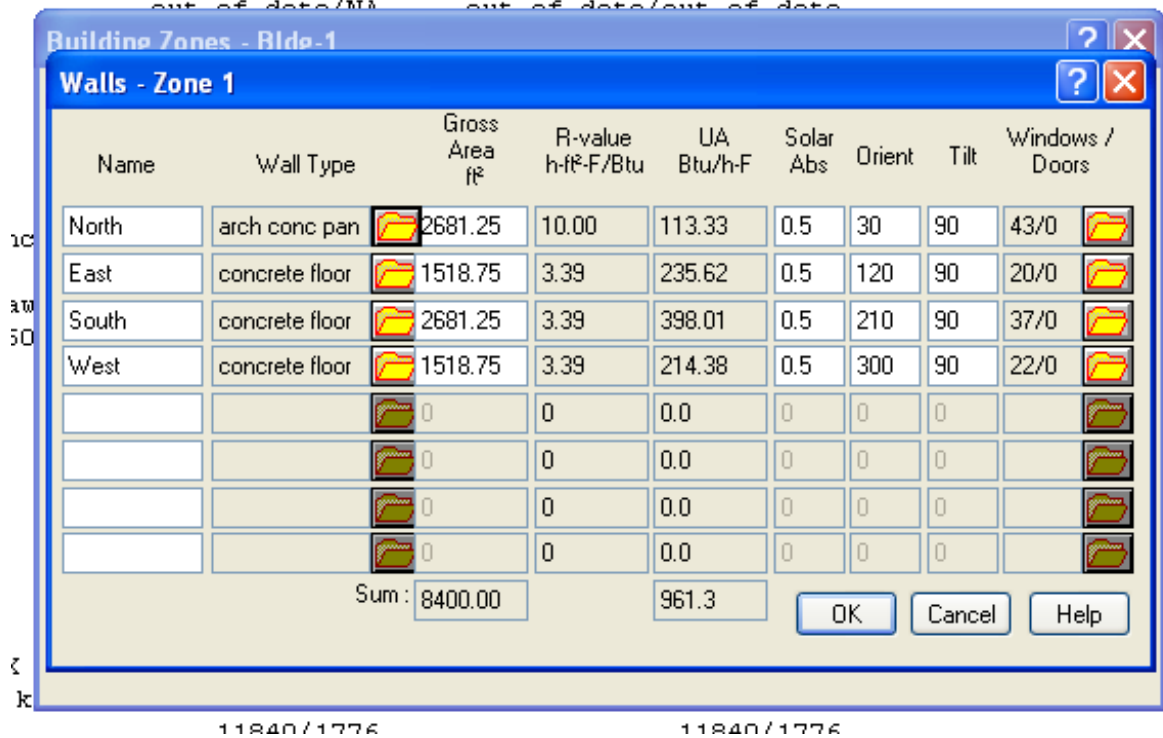


Fig 9

After putting in all your information for building 1 you click on the Buildings button from the menu and copy building 1 to building 2. This will make sure you have exactly two of the same buildings. Then going back into building 2 you can change your façade panels to a different R Value and run a simulation to find your energy savings. So going into building 2 and clicking on the walls button again, I changed the R Value to match that of the Versawall and the Dimension Series panels, R-30 and R-20. To simulate an annual energy usage and annual utility cost you simply select “Misc” from the menu and select “Simulate...”(Fig 10). After this another box will appear and you click “ok”. The first window you see is the Annual Energy Use graph, building 1 in red and building 2 in green (Fig 11 & 12).

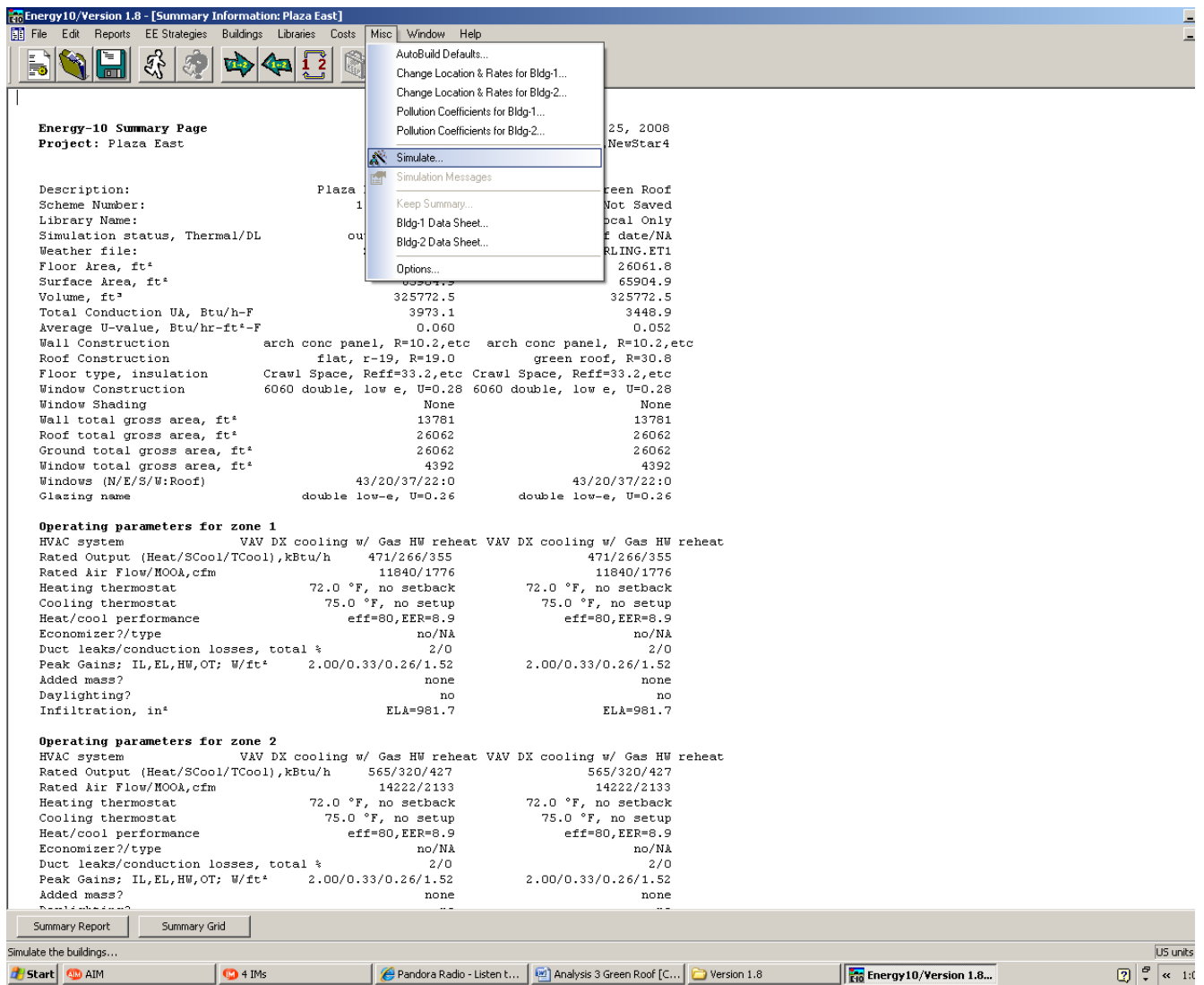


Fig 10

Be reminded the calculations will only be for the top floor because Energy 10 tends to not simulate correctly when given too large of an area to calculate. The answer given was still recommended to be a close comparison to a percentage for the whole building considering each floor is fairly similar. After finding the answers you would also have to multiply by two, considering Plaza East is two separate buildings.

## Conclusion:

The results of energy saved per year from Versawall were (**Fig 11**): 1.6 kBtu/ft<sup>2</sup> Heating, -0.3 kBtu/ft<sup>2</sup> Cooling, -0.1 kBtu/ft<sup>2</sup> Other, and a total of 1.1 kBtu/ft<sup>2</sup>. The Annual Energy Costs savings were very minor at \$0.012/ft<sup>2</sup>. The results of energy saved per year from Dimension Series were (**Fig 12**): 1.90 kBtu/ft<sup>2</sup> Heating, -0.1 kBtu/ft<sup>2</sup> Cooling, and a total of 1.8 kBtu/ft<sup>2</sup>. The Annual Energy Costs were also very minor at \$0.041/ft<sup>2</sup>. Multiplying by two wouldn't give that much more energy savings, considering the low numbers found. Even though a strict rate could not be given on how much quicker the erection time could be, it was still said to be higher than precast. This in turn saves time and money for the project. The LEED points also given to the new materials are also a positive addition to the new façade.

With these results the new façade does not affect much energy use or cost savings, but the money saved on material and assembly could be a good reason to look into the material for this project or the next project. In addition, one should also take note the material does have some durability, but possibly not as much as precast would have, which Tishman Speyer usually looks for. Further investigation will be put into combining each new façade's energy savings results with the new green roof energy savings results in Analysis 2.



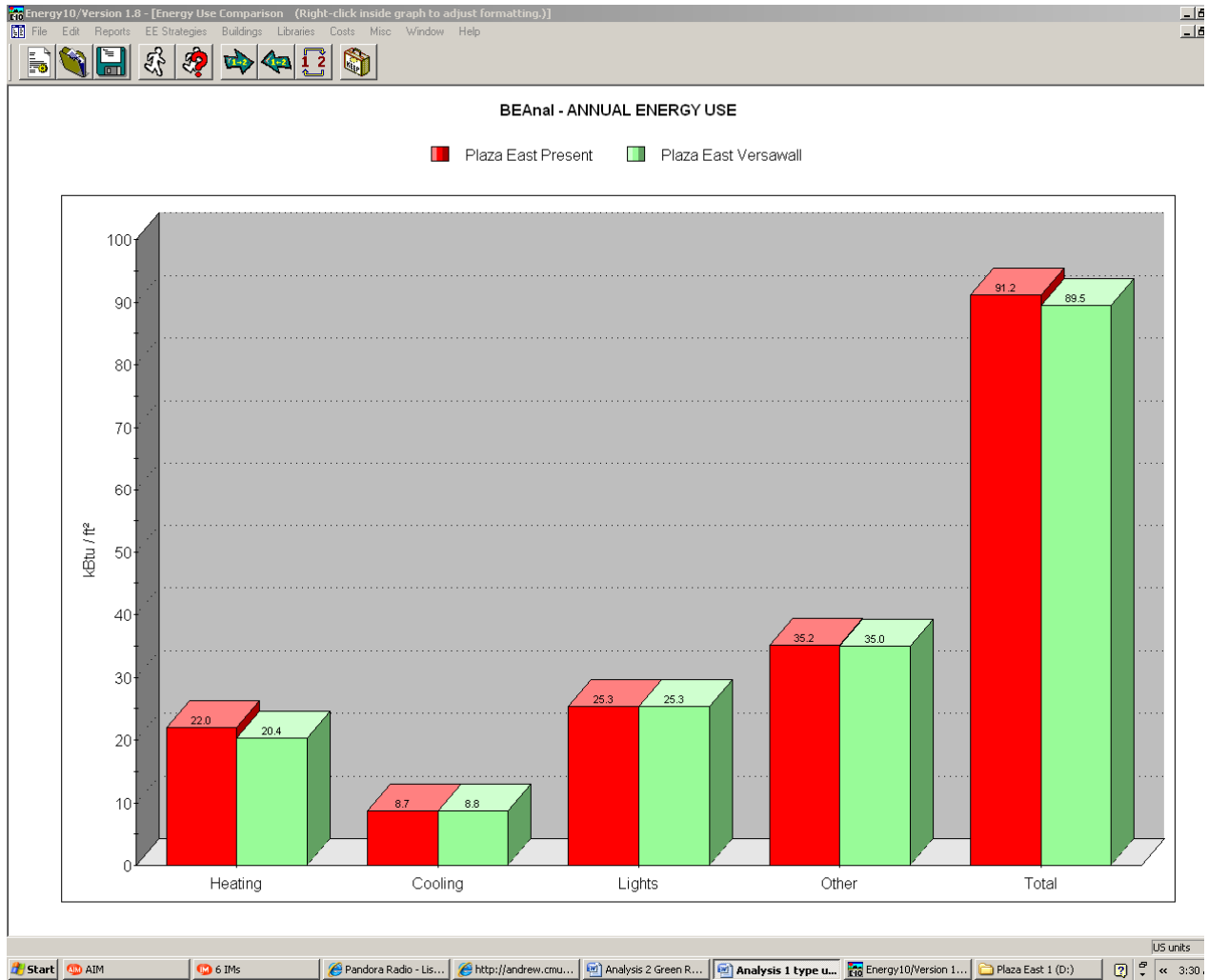


Fig 11

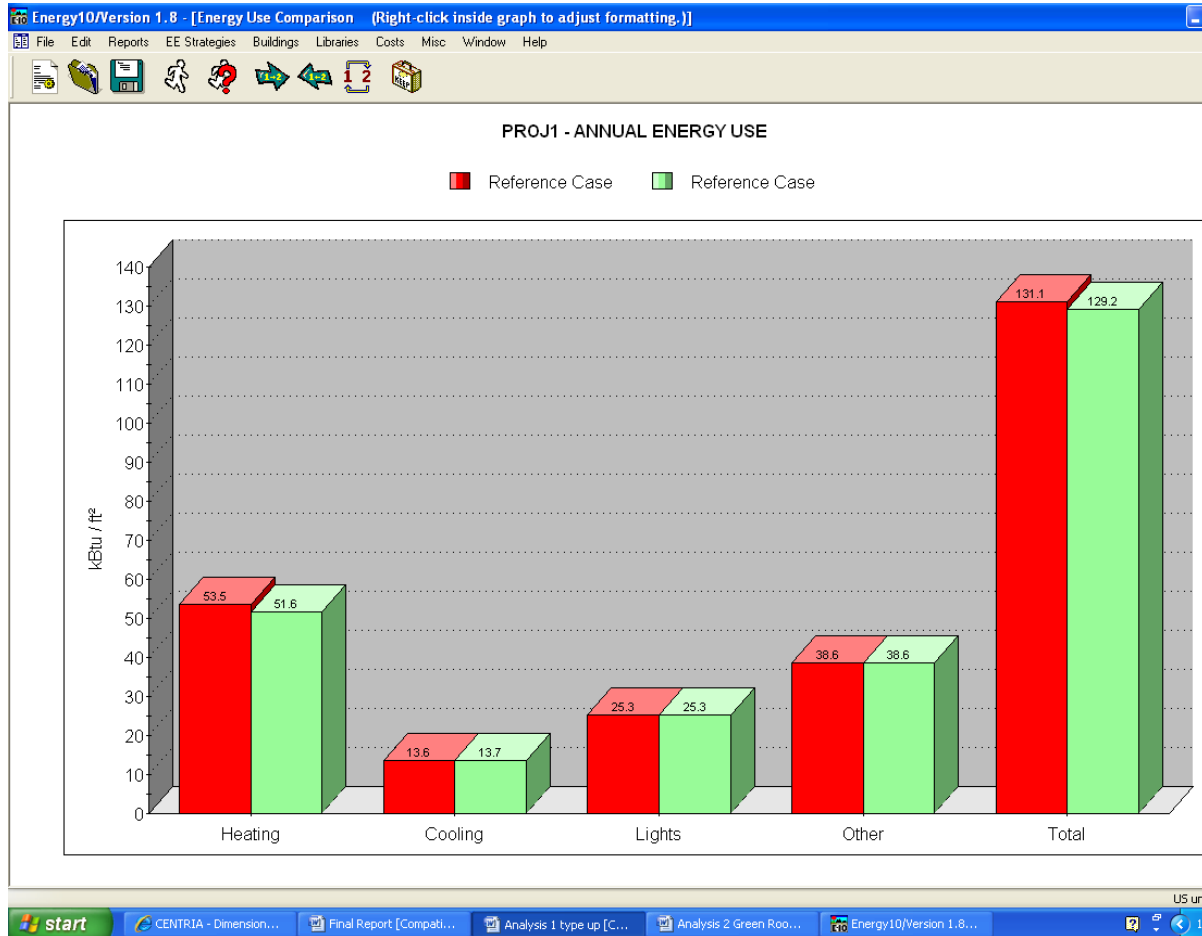


Fig 12

## Analysis 2: Green Roof Implementation

### Issue 2:

The roof is a regular built up roof with no general real problem, but with a green roof replacement, Plaza East could benefit in many ways.

### Analysis:

Green roofs will be researched to be in place of the current built up roof. Adding a green roof to a project can have multiple advantages. It is expected to cost more than the original roof designed for Plaza East, but the cost savings, in the long run, could be much better. With a green roof you can have a higher LEED accreditation, reduced energy costs, and extended roof