

50 Connell Drive

Berkeley Heights, NJ

AE Senior Thesis 2009

April 14th, 2009



About Myself

Jason Salyer

Construction Management

Program

- 5th year Penn State AE

Hometown

- Poughkeepsie, NY



Professional Experience:

- Whiting-Turner 2007
 - Loyola Dormitory
- Turner Construction 2008
 - WTC Tower 2

Topics to be Presented

Analysis 1 – Panelized Façade System

Analysis 2 - High Performance Glazing

Analysis 3 - Prefabrication

Industry Issue - Reducing Operating Costs



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Background Info

Major Players:

Owner: Connell Real Estate & Development

CM: Turner Construction for Core & Shell

Architect: HLW International

General Data:

- 4 Story High End Office Building with Cafeteria
- 185,000 Total Square Feet
- \$38.9 Million Construction Cost
- Dates of Construction (core & shell):
July 2007 to January 2009



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Background Info

Location:



20 miles west of NYC & adjacent to I-78

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Background Info

Structural:

- Concrete Footings
- Grade Beams
- Structural Steel Frame
- Composite Floor Slabs
- Vertical Steel Cross Bracing

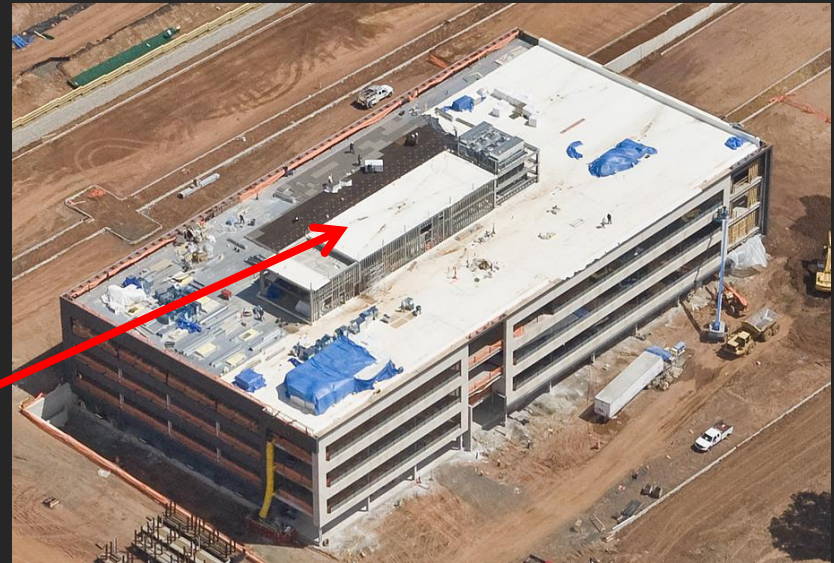


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Background Info

Mechanical Systems:

- Concealed Mechanical Penthouse
- 2 Air Cooled Condensing Units (ACCU's) per floor
- 2 pipe direct return air/water system
- 2 AHU's supply 100% OA to the ACCU's



Mechanical Penthouse

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Panelized Facade System

1



2



3



4



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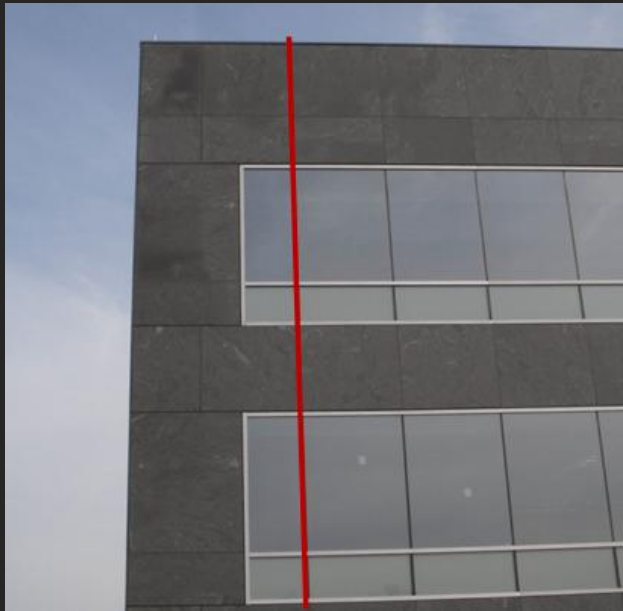
Panelized Facade System

The Problem

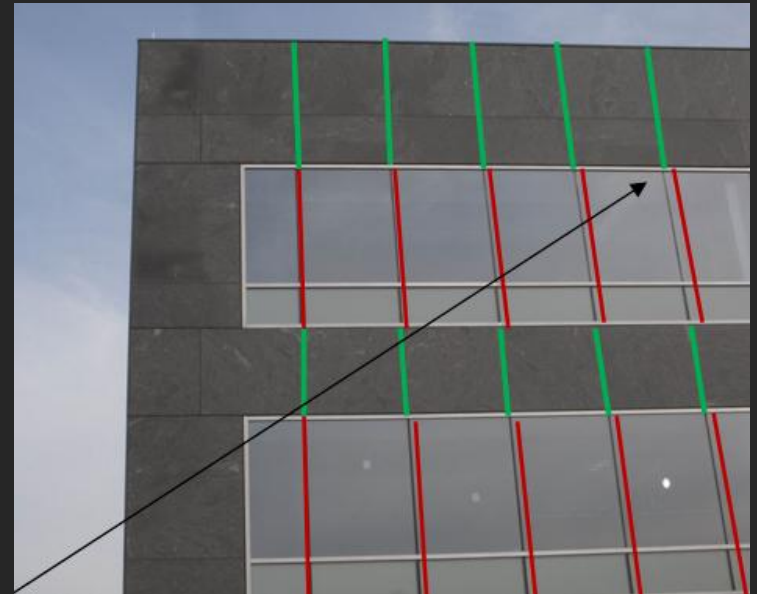
The vertical joints between the window panels & stone panels were out of alignment

Each contractor blamed the other

20% of windows had to be removed



Correct Alignment



Misalignment Joints

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Panelized Facade System

Problem Statement:

Could using a single contractor for the façade prevented the alignment problems?



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Panelized Facade System

Potential Solution:

Integrated Contractor

Advantages	Disadvantages
Less Coordination	Finding Qualified Bidders
Strong Incentive for Quality Work	Chance of Subcontracting a Work Package
Eliminates “Finger Pointing”	CM has less Control Over the Process
Subs Claim it is More Cost Effective	Unqualified Subcontractor May get Hired
Subcontractor would be More Likely to Work Through a Problem on Their Own	Subcontracting Defeats the Goal of Using An Integrated Contractor

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Panelized Facade System

Conclusion: Using an integrated contractor is not feasible since the disadvantages have major implications

- Shop drawing coordination is the key to success

Another Option:

Dedicated Quality Control Staff:

- Probably would have caught problem sooner
- \$8,000 more per month
- Regular field personnel could be just as effective

The experience was a lesson learned for everyone involved

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High Performance Glazing

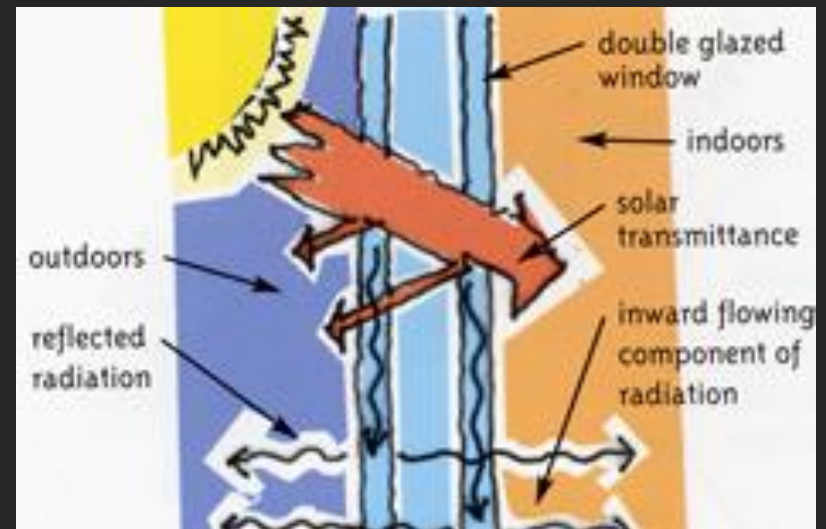
Problem Statement

Can replacing the vision glass with a more energy efficient glass result in long run energy & equipment savings for the owner?



Methodology

1. Research and select a new type of glass
2. Perform energy modeling simulation
3. Compare costs



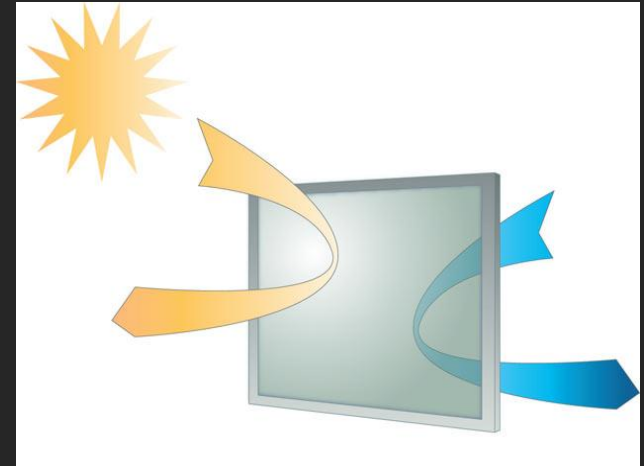
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High Performance Glazing

Current Glass - YCW 750 Spline Tech

Proposed Glass -Solarban[®] 70XL

Product Description: SolarBan is a revolutionary new Solar Control, Low-E glass manufactured by PPG that has been recognized as one of the most energy efficient on the market



Glass	U-Value
SplineTech 750	0.45
SolarBan70XL	0.26

SolarBan has a lower rate of heat transfer

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High Performance Glazing

Material Cost Comparison:

Glazing Type	Square Foot Cost	Size of Panels (sf)	Cost per Unit	Number of Glass Units	Total Material Cost
Spline Tech	\$10.45	35	\$365.75	589	\$215,427
SolarBan70XL	\$9.25	35	\$323.75	589	\$190,689

Upfront Savings = \$25,000



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High Performance Glazing

Simulation Results

Glazing Type	Estimated Operating Expenses	Annual Operating Savings	Estimated Total Capital Cooling HVAC Costs	Initial Capital Cost Savings	1st Year Savings
Spline Tech	\$1.56/sf	N/A	\$7.63/sf	N/A	N/A
SolarBan70XL	\$1.41/sf	\$25,500*	\$6.34/sf	\$1.29/sf	\$244,800*

*Based on 170,000 sf of office space

The DOE's 2.2 Building Energy Analysis Simulation Tool was Used for this estimate

Over \$200,000 saved in initial equipment cost

\$25,500 saved per year in utility bills



SolarBan was used on this university building

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High Performance Glazing

Summary of Findings

Glazing Type	U-Value	Square Foot Cost	Cost per Unit	Total Glass Material Cost	Glass Material Cost Savings	Estimated Energy Reduction	Estimated Equipment Cost Reduction
Spline Tech	0.45	\$10.45	\$365.75	\$215,427	N/A	N/A	N/A
SolarBan70XL	0.26	\$9.25	\$323.75	\$190,689	\$24,738	9%	16%

Conclusion:

SolarBan70XL provides significant cost savings

- 9% Energy Reduction
- 16% Equipment Cost Reduction

SolarBan70XL should be used in place of SplineTech750

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Prefabrication

Problem Statement:

Would replacing the mechanical equipment with a modular central plant be beneficial for the project?



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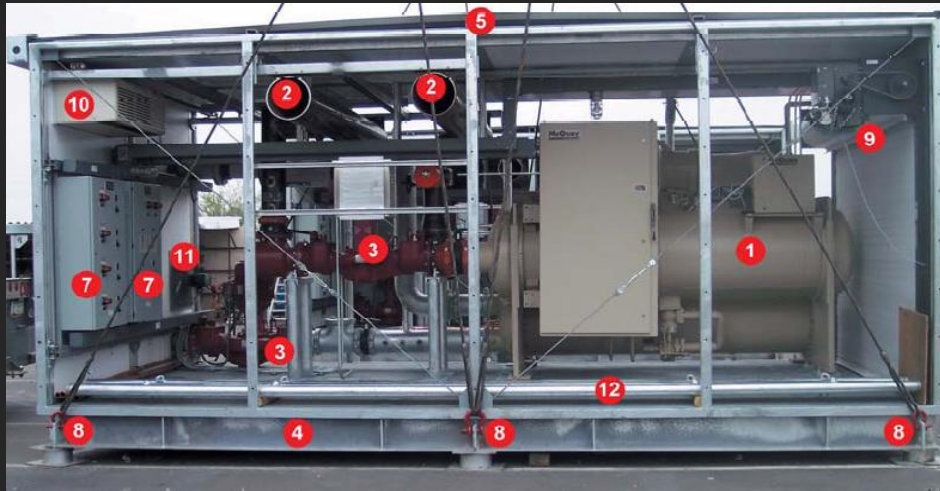
Prefabrication

What is it?

Modular Plants Combine

- Chiller
- Pumps
- Cooling Tower
- Interconnecting Pipes

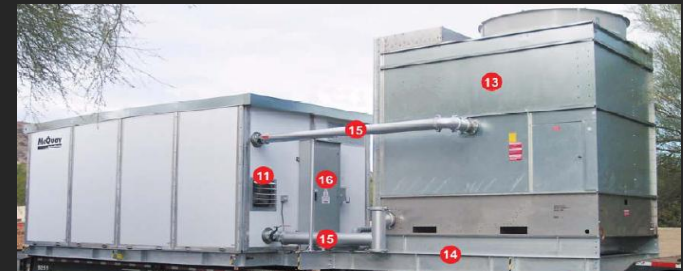
All in one pre-assembled module



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Prefabrication

Modular Central Plant vs. Site Built Plant	
Advantages	Disadvantages
Reduced owner & contractor risk	Long lead time
Single source supplier	Heavy loads
Fast site assembly time	Structural coordination
Reduced trade coordination	Rigging & crane requirements
Less field labor required	Vibration isolation
Easily expandable	May need to locate on grade

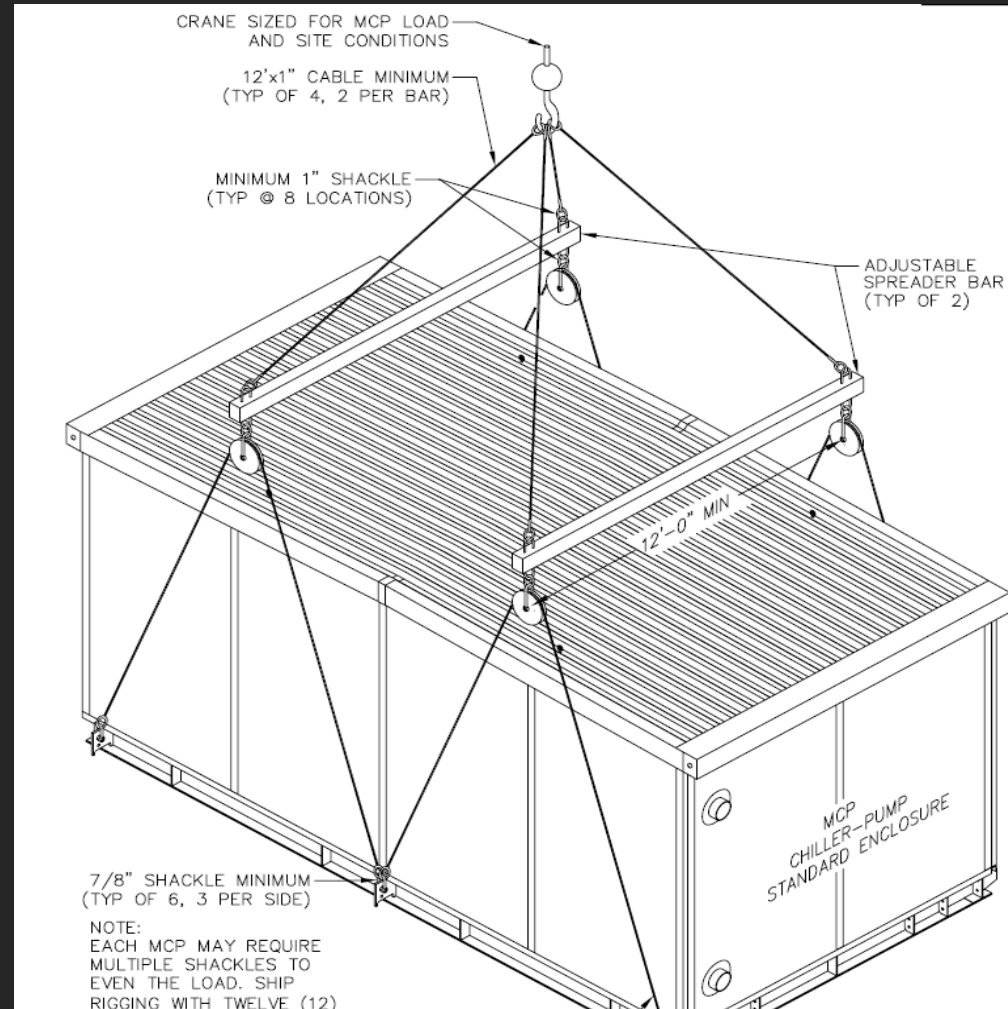


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Rigging Requirements

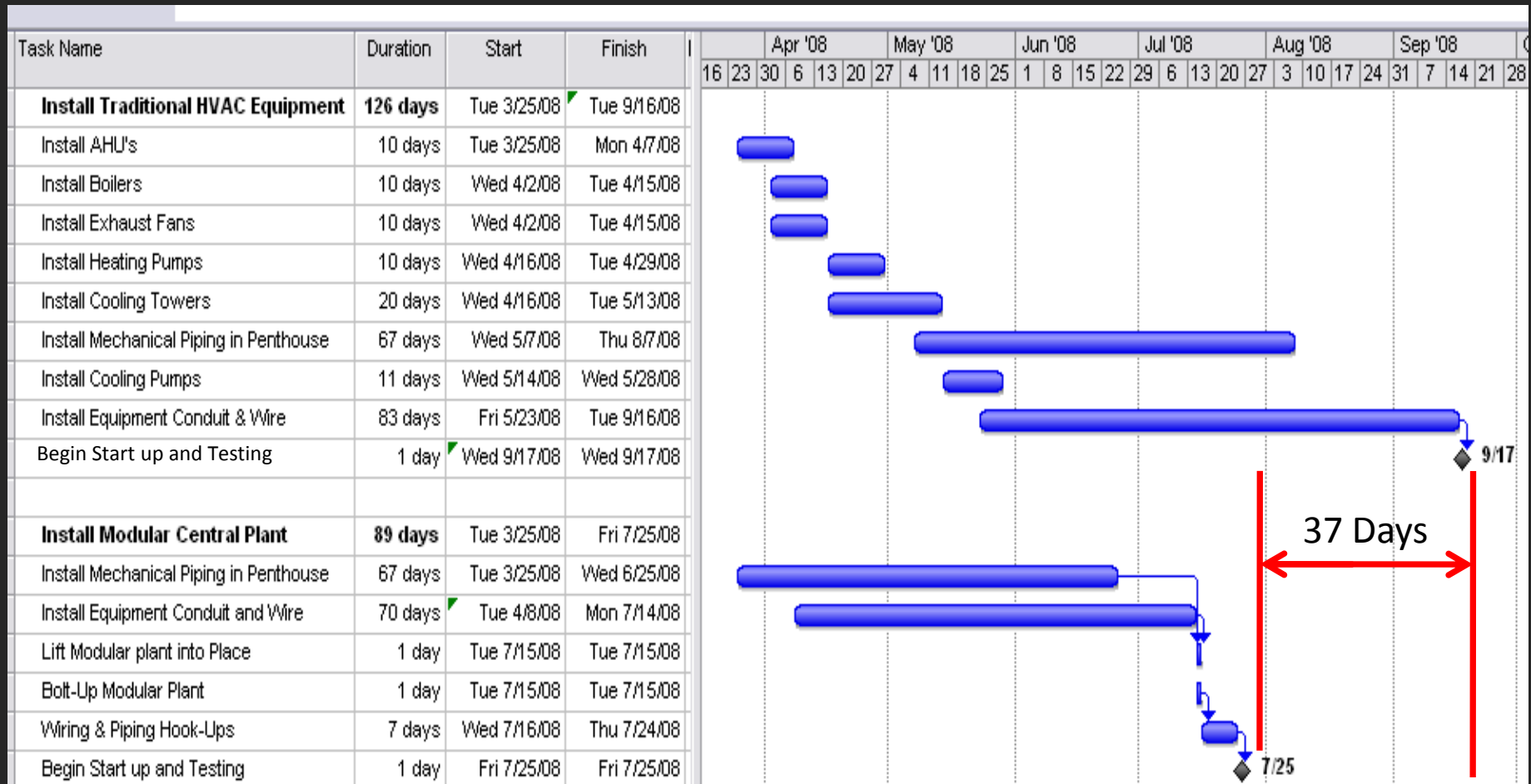
- 66 Ton Equipment Weight
- Must balance load
- Multiple Spreader Bars & Shackles
- 1" Cables, 1" Shackles Minimum
- Experienced Rigging Crew Essential



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Modular vs. Site Built Plants



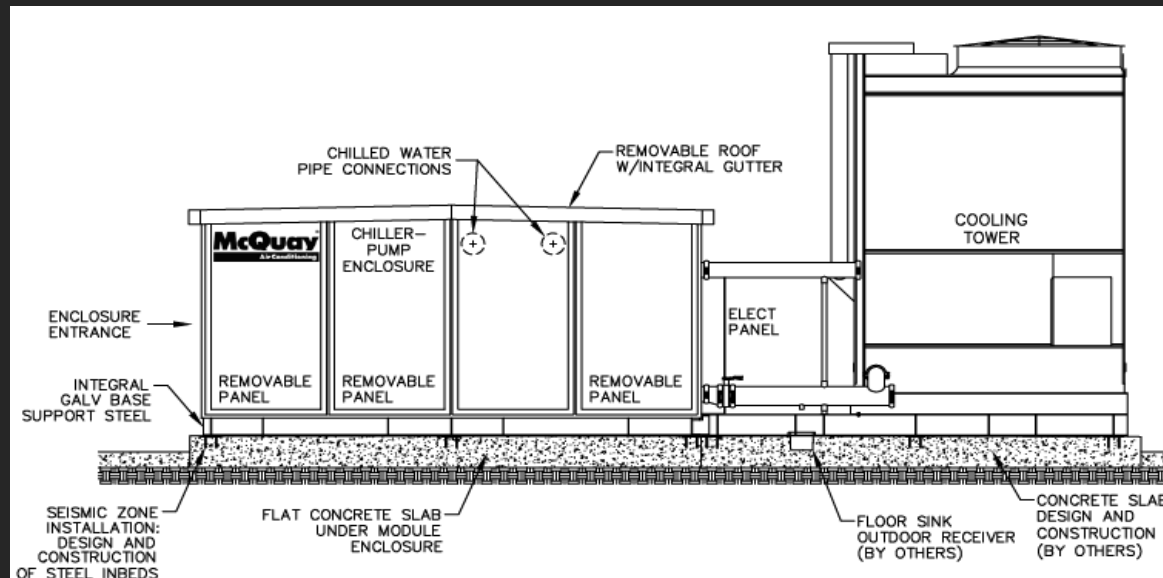
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STAAD Analysis: Supporting W18x35 will deflect at least 2" = **not acceptable**

2 Options

1. Increase size of structural members = \$\$\$
2. Locate on grade = Eyesore



Elevation of MCP Located on Grade

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Prefabrication

Design Concern #1

High Volume of Air Required compared to the 8 ACCU's



What does this mean?

MCP would require 185,000 CFM (total supply & return)

This requires 2 vertical shafts (supply & return) each measuring 6' x 7'

Why is this Bad?

1. Too much floor space used – Lack of vertical shaft space
2. Large ductwork heavier & more expensive to construct & support
3. Supply & return fan would be required
4. Very high horsepower motors required for fans

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Design Concern #2

Service failure = no AC for entire building

Why is this bad?

The building is unoccupiable until the unit is fixed.

What about the current design?

2 units per floor provide cooling

If one unit fails the other unit can still cool the floor while the other is being repaired

All units are required only for peak design load



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Design Concern #3

Replacement parts are large must be special ordered

What does this mean?

Must keep parts in stock or wait until they arrive for service

Why is this bad?

1. Long lead time
2. The building may be without cooling capabilities for an extended period of time

Example:

Replacement motors for the fans are very large and may require a crane.

The parts for the actual equipment are smaller and easily attainable.



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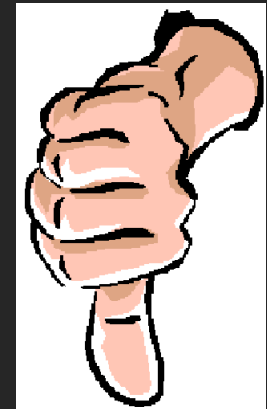
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Conclusion

A modular plant is not a good option for this building

Why?

Even though it has a faster installation time the disadvantages create bigger problems.



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Reducing Operating Costs

Critical Industry Issue

Energy Costs are expected to rise dramatically in the next decade

Techniques to Reduce Costs

1. Energy modeling prior to construction
2. Use of efficient equipment & water efficient fixtures
3. Take advantage of state rebates for efficient equipment
4. Energy monitory
5. Optimizing operating set points
6. Continuous commissioning



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The End

Questions or Comments?



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