Architectural Engineering
Construction Management
Senior Thesis

April 11th, 2011

Consultant: Dr. Riley

Diab Shetayh

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Presentation outline

I. Project Overview
II. Project Team
III. Overview of Analyses
IV. Analysis 1 – LEED Certification
V. Analysis 2 – Brick Façade
VI. Mechanical Breadth
VII. Analysis 3 – BIM Coordination
VIII. Conclusion
IX. Acknowledgements
X. Questions

Diab Shetayh

Presentation Outline:

Project Overview

Project Title: Paint Branch High School

Function: Education

Location: Burtonsville, MD

Building Size: 349,000 SF

Project Cost: $ 80,973,293

Date of Construction: 12/15/2009 – July 30, 2013

Delivery Method: Modified CM @ Risk

Presentation Outline:

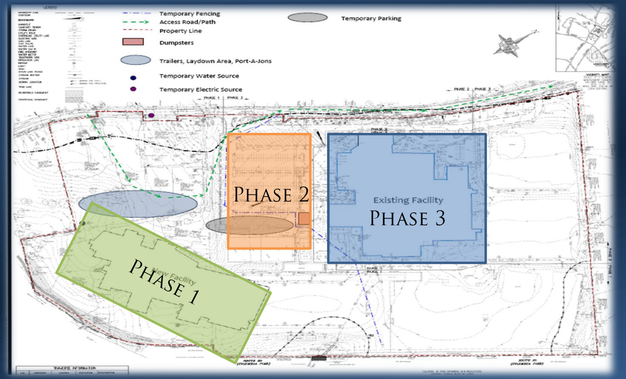
Project Overview

Phase 1:
- Construction of the new facility
- Substantial completion date: June 1, 2012

Phase 2:
- Reconfigure Parking lots for staff & Students
- Substantial completion date: August 19, 2011

Phase 3:
- Abatement & demolition of old facility
- Substantial completion date: July 30, 2013

PB Phase Diagram



Presentation Outline:

Project Team

Owner:	Montgomery County Public Schools (MCPS)
Architect:	Moseley Architects
Construction Manager:	HESS Construction + Engineering Services
Civil Engineer	ADTEK Engineers
MEP Engineer:	B2E Consulting Engineers
Structural Engineers:	Wolfman & Associates

Project Team

Presentation Outline:

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Overview of Analyses

Analysis 1: LEED Certification

- Reviewing LEED scorecard for opportunities
- Analyzing opportunities for additional costs

Analysis 2: Brick Façade

- Cost & Schedule impact to project
- Mechanical Breadth
- Structural Breadth

Analysis 3: BIM Coordination

- Reviewing clash detection logs and case studies
- Determine cost and schedule savings to project

Presentation Outline:

Analysis 1 – LEED Certification

Problem:

- State of the art High School
- LEED Gold Certified (43 Points)

Research Goals/Methodology:

- Review LEED scorecard for opportunities
- Achieve LEED Platinum Certification (52 Points)

LEED Version 2.2

Green Schools Statistics

Daylight:

- With brighter learning environments, test scores increase by 25%
- Ability to learn 20-25% faster on standardized tests

Air Quality:

- Children miss 10 million school days a year due to asthma
- Poor air quality can cause mold growth and disease to spread

Acoustics:

- Students score up to 20% higher on word recognition tests
- Poor acoustics cause distraction, which affects a students ability to learn

Presentation Outline:

LEED Scorecard

Su		
Cr		Points
		1
En		Points
Cr		1-3
Cr		1
Cr		1
In		Points
Cr		1
Cr		1
Cr		1
		9

Sustainable Sites
- **Credit 7.1** – Heat Island Effect, Non-Roof
  - Placed 50% of parking under canopy

Energy & Atmosphere
- **Credit 2.1** – On-Site Renewable Energy
  - Incorporated Wind Turbine on site
- **Credit 4** – Enhanced Refrigerant Management
  - Changed refrigerant to R134A
- Credit 5 – Measurement & verification
  - Third Party to establish plan

Indoor Environmental Quality
- **Credit 1** - Outdoor Air Delivery Monitoring
  - Incorporated CO2 monitoring Systems
- **Credit 5** - Indoor Chemical & Pollutant Source Control
  - Proposed entry grates at all major entrances
- **Credit 7.1** - Thermal Comfort, Design
  - Heating & Cooling loads to be calculated by ME

Presentation Outline:

Credit 7.1 – Heat Island Effect, Non-Roof

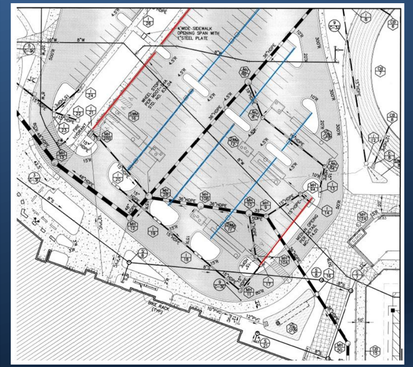
Requirements:

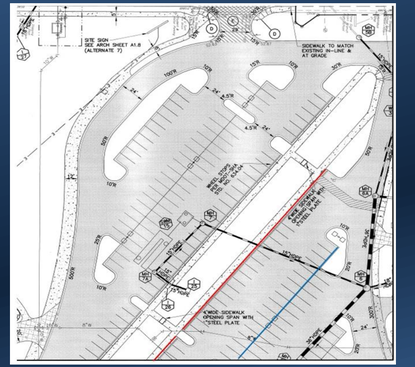
- 50% of parking spaces under deck/roof
- Material used must have a Solar Reflectance Index (SRI)[2] of at least 29

Total Parking spaces: 355

Total Parking Spaces Required: 178

Total Parking Spaces Under Canopy: 188





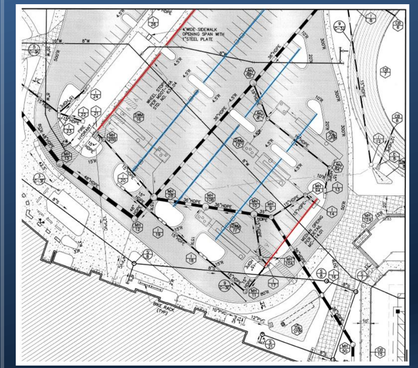
= Single cantilever System

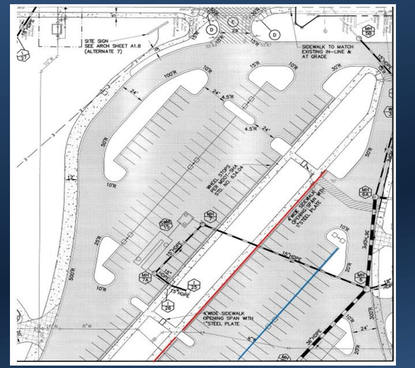
= Double Cantilever System

Presentation Outline:

Credit 7.1 – Cost Analysis

Cost Analysis				
Canopy System	Total Parking Spots	Total Linear Ft	Cost/LF	Total Cost
Single Cantilever	47	470	$300	$ 141,000
Double Cantilever	141	780	$600	$ 468,000
Total	188	1,250	$900	**$ 609,000**





= Single Cantilever System

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Diab Shetayh

Presentation Outline:

Complete Cost Analysis

LEED Cost Analysis			
Sustainable Sites		Points	Cost
Credit 7.1	Heat Island Effect, Non Roof	1	$609,000
Energy & Atmosphere		Points	Cost
Credit 2.1	On-Site Renewable Energy	1-3	$25,000
Credit 4	Enhanced Refrigerant Management	1	N/A
Credit 5	Measurement & Verification	1	$55,000
Indoor Environmental Quality		Points	Cost
Credit 1	Outdoor Air Delivery Monitoring	1	$123,200
Credit 5	Indoor Chemical & Pollutant Source Control	1	$156,695
Credit 7.1	Thermal Comfort, Design	1	N/A
	Total Possible Points/Cost	**9**	**$968,859**

Analysis 1 Conclusion

Advantages:

- Savings in operating costs
- Increased Test Scores
- Cleaner learning Environment

Disadvantages:

- High Upfront Cost

Presentation Outline:

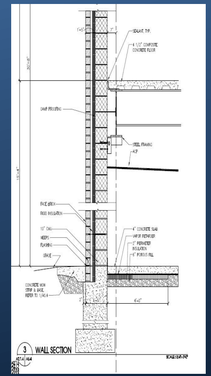
Analysis 2 – Brick Façade

Problem:

- Congested site
- Façade is primarily face brick

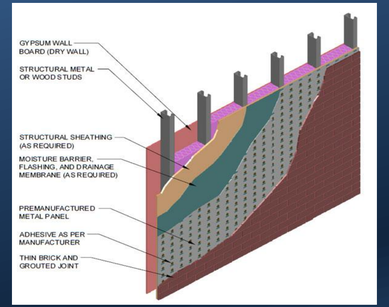
Research Goals/Methodology:

- Contacting Prefab. Manufacturers
- Determine cost & Schedule impact with new system



Current System:

- 4" face brick
- 1" Air Space
- 2" Rigid Insulation
- 10" CMU



Proposed System:

- 1" face Brick
- 3.5" Polyurethane
- 4" Steel Stud
- 5/8" Gypsum Board
- 1" Membrane (2)
- ½" Fiberboard

Presentation Outline:

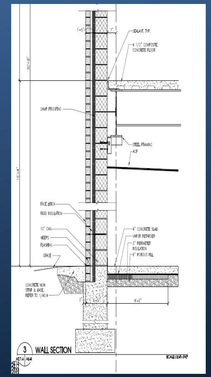
Calculations

Total SF of Brick: **108,000 SF**

Prefab. Panel Size: 12' X 40' = **480 SF**

Total Number of Panels Needed: **225 Panels**

Panels Installed Per day : **8-15 panels (5 man crew)**



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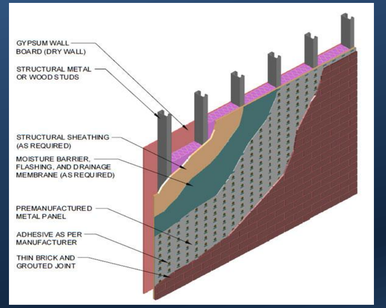

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Presentation Outline:

Façade Comparison

Masonry Systems Comparison			
Original Masonry System			
Duration	Cost/SF	SF of Brick	Total Cost
139 Days	$20.62	108,000	$2,226,960.00
Prefabricated Masonry Panels			
Duration	Cost/SF	SF of Brick	Total Cost
19 days	$40.00	108,000	$4,320,000.00

Schedule Savings: 139 Days – 19 Days = **120 Days (6 Months)**

Additional Cost: $4,320,000 - $2,226,960 = **$2,093,040**

Analysis 2 Conclusion

Advantages:

- Decrease in Project Schedule
- Minimize Site Congestion
- Better quality

Disadvantages:

- More Expensive System

Presentation Outline:

Mechanical Breadth

Comparison in R –values and U-values

Calculate each systems heat transfer

Conduct cost analysis between both systems

Current System:
- 4" face brick
- 1" Air Space
- 2" Rigid Insulation
- 10" CMU

Proposed System:
- 1" face Brick
- 3.5" Polyurethane
- 4" Steel Stud
- 5/8" Gypsum Board
- 1" Membrane (2)
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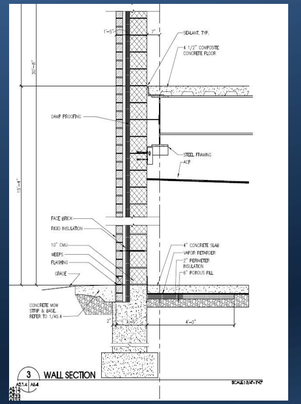
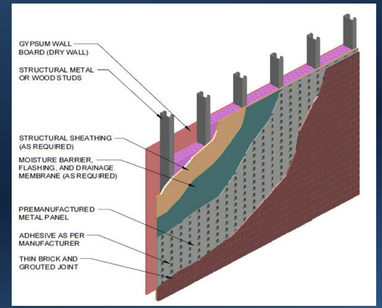
Wall Sections



Current System



Proposed System

Presentation Outline:

Current Façade

R & U Values (Brick Façade)			
Material	Material Thickness	R-value/inch	R-value
Air Film	1"	1.00	1.00
Brick	4"	0.011	0.44
CMU	10"	1.20	12.00
Insulation	2"	4.00	8.00
		Total R-value	21.44
		U-Value (1/R)	**0.046641791**

Proposed Façade

R & U Values (Prefabricated System)			
Material	Material Thickness	R-value/inch	R-value
Brick	1"	0.11	0.011
Polyurethane	3.5"	6.25	21.875
Steel Stud	4"	1.38	5.52
Gypsum Board	0.625"	0.56	0.35
Membrane (2)	0.08"	1.00	0.16
Fiberboard	0.5"	1.32	0.66
		Total R-values	28.576
		U-Value (1/R)	**0.034994401**

Presentation Outline:

Cost ANALYSIS

Cost Analysis			
Summer: ΔT = 100-75 = 25F			
Brick Façade	q=0.0467*108,000*25F=126,090 BTU/h	126,090*4,380=552,274,200 BTU/yr.	
Prefabricated Façade	q=0.0350*108,000*25F=94,150 BTU/h	94,500*4,380=413,910,000 BTU/yr.	
		Difference	138,364,200 BTU/yr.
			40,584.66 kWh/yr.
Cost/kWhr in MD = $0.125kWh		**Cost Difference**= 40,548.66*$0.125= **$5,068.58/yr.**	
Winter: ΔT = 70-16 = 54F			
Brick Façade	q=0.0467*108,000*54F=272,354.4 BTU/h	272,354.4*4,380=1,192,912,272 BTU/yr.	
Prefabricated Façade	q=0.0350*108,000*54F =204,120 BTU/h	204,120*4,380=894,045,600 BTU/yr.	
		Difference	298,866,672 BTU/yr.
			87,585.11 kWh/yr.
Cost/kWh in MD = $0.125 kWh		**Cost Difference**= 87,585.11*$0.125= **$10.948.14/yr.**	
			Total Savings per year: $16,016.72

Cost ANALYSIS

Alternative Interior Finish:

- Changed CMU finish to Gypsum wall board
- Changed Rigid insulation to Polyurethane

Gypsum Board Estimate					
Material	Mat'l Cost/SF	Labor Cost/SF	Area/Panel (ft^2)	Total Panels	Total Cost
Gypsum Wall Board	$0.48	$0.54	480	225	$109,404.00
Polyurethane	$1.50		480	225	$162,000.00
				Total=	**$271,404.00**

Presentation Outline:

Analysis 3 – BIM Coordination

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Presentation Outline:

Presentation Outline:

Presentation Outline:

Conclusion

Analysis 1:

- Achieved LEED Platinum Certification
- Total Additional Cost - $968,859

Analysis 2:

- Additional Cost w/ Prefab System - $2,093,040
- Savings in project schedule – 6 months

Presentation Outline:

Acknowledgements

Academic Acknowledgements:

- Dr. Riley – CM Advisor
- Dr. Robert Leicht
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- Penn State AE faculty

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- George Houke (HESS Construction)
- Paint branch Project Team

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