Moon Area High School and District Administration Offices
Moon Township, PA
4.13.2010

KRISTOPHER BRICE
Construction Management
AE Senior Thesis Presentation
The Pennsylvania State University

New Moon Area High School
& District Administration Offices

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

Conclusions

Questions

Image provided by Eckles Architecture & Engineering, Inc

New Moon Area High School
& District Administration Offices

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

Conclusions

Questions

PROJECT OVERVIEW

- **Owner**
  Moon Area School District
- **Occupancy Type**
  Educational
- **Size**
  291,387 SF
- **Cost**
  $ 70,802,784 (Design+Construction)
- **Construction Duration**
  January 2009 – November 2010
- **Delivery Method**
  Design-Bid-Build w/CM Agent

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

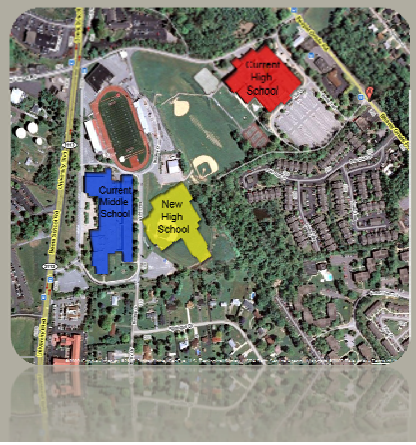
Conclusions

Questions

PROJECT OVERVIEW

- **Owner**
  Moon Area School District
- **Occupancy Type**
  Educational
- **Size**
  291,387 SF
- **Cost**
  $ 70,802,784 (Design+Construction)
- **Construction Duration**
  January 2009 – November 2010
- **Delivery Method**
  Design-Bid-Build w/CM Agent

New Moon Area High School & District Administration Offices



Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

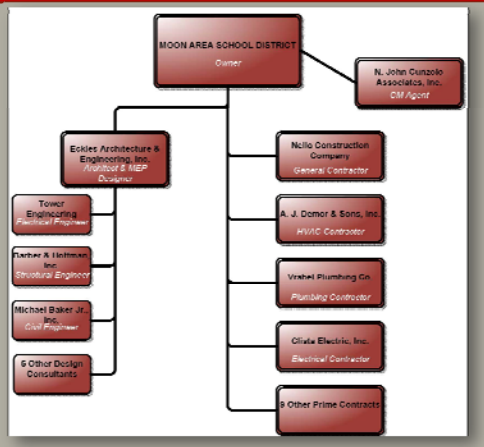
Conclusions

Questions

PROJECT TEAM

- **Architect & MEP Designer**
  Eckles Architecture & Engineering, Inc.
- **Construction Manager**
  N. John Cunzolo Associates, Inc.
- **General Contractor**
  Nello Construction Company
- **HVAC Contractor**
  A. J. Demor & Sons, Inc.
- **Plumbing Contractor**
  Vrabel Plumbing Co.
- **Electrical Contractor**
  Clista Electric, Inc.

New Moon Area High School & District Administration Offices



ANALYSIS ONE

o **Opportunity**

In the case of the New Moon Area High School, the building and some of its systems were modeled using 3-dimensional software, but the models were not made available to the construction team. There is a great potential for this project and others like it to benefit from BIM in the future.

o **Objective**

Develop a strategy for making BIM available for contractors in a multiple prime delivery by providing the tools needed to smoothly integrate several specific BIM uses into this widely used delivery method.

Image provided by Pickles Architecture & Engineering, Inc.

CONCLUSIONS

- **Challenges**
  - Concern over liability among designers
  - Unpredictable contractor pool
  - Model transfer and level of detail (LOD)
  - Owner support
- **Keys to Success**
  - Utilize AIA E202-2008 BIM Protocol Exhibit
  - Redevelop specifications for coordination
  - Consider HVAC contractor for leading coordination
  - Start with 3-4 simple BIM uses

Image provided by Eckles Architecture & Engineering, Inc

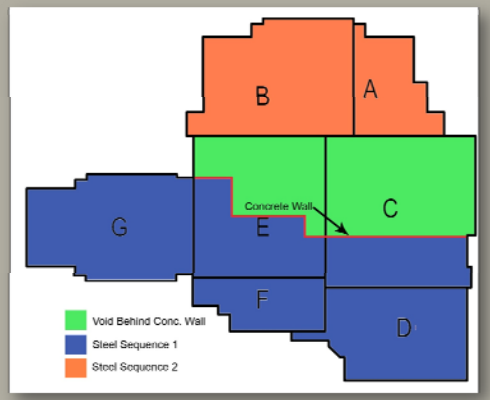
ANALYSIS TWO

o **Opportunity**

The original design of the foundation wall resulted in a disjointed construction sequence along with the need for the temporary enclosures for parts of construction.

o **Objective**

Determine if a bracing design will allow the first floor of Areas C&E to be completed in sequence with the rest of the structure and further reduce the overall construction schedule.



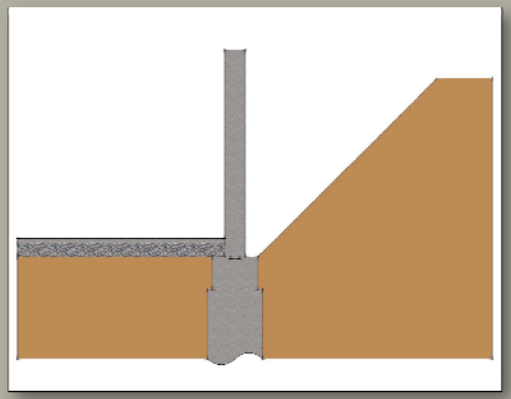
FOUNDATION WALL DESIGN

- **Size**
  - 15 feet tall
  - 18" thick
  - 436 feet long
- **Support**
  - 28" x 40" grade beam
  - 48" concreted caissons

Image provided by Eckles Construction Services, Inc

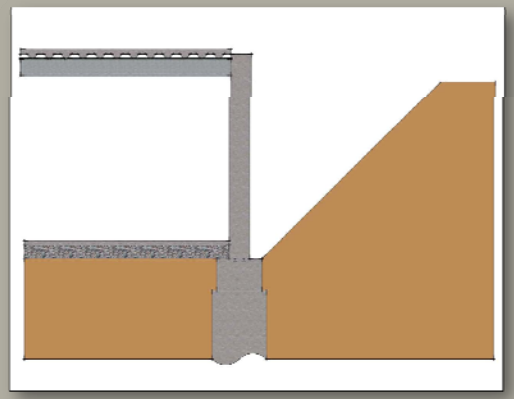
FOUNDATION WALL DESIGN

- **Size**
  - 15 feet tall
  - 18" thick
  - 436 feet long
- **Support**
  - 28" x 40" grade beam
  - 48" concreted caissons
- **Backfill Requirements**
  - First floor steel and slab must be in place
  - Slab required to be at 28-day strength



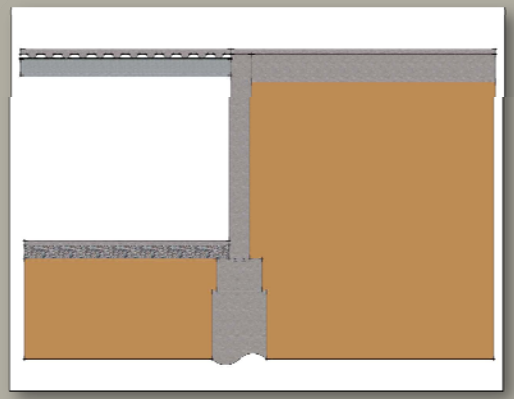
FOUNDATION WALL DESIGN

- **Size**
  - 15 feet tall
  - 18" thick
  - 436 feet long
- **Support**
  - 28" x 40" grade beam
  - 48" concreted caissons
- **Backfill Requirements**
  - First floor steel and slab must be in place
  - Slab required to be at 28-day strength



FOUNDATION WALL DESIGN

- **Size**
  - 15 feet tall
  - 18" thick
  - 436 feet long
- **Support**
  - 28" x 40" grade beam
  - 48" concreted caissons
- **Backfill Requirements**
  - First floor steel and slab must be in place
  - Slab required to be at 28-day strength



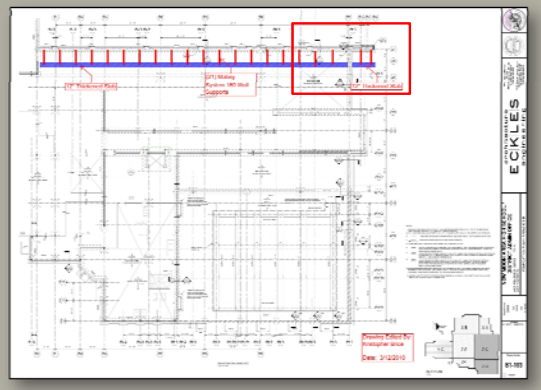
BRACING DESIGN AND LAYOUT

- **Mabey Bridge & Shore, Inc – System 160 Bracing**
  - Distribution within 20 miles of site
  - Relatively lightweight
  - Small enough not to interfere with construction
  - Favorable compressive strength

Image provided by Mabey Bridge & Shore, Inc

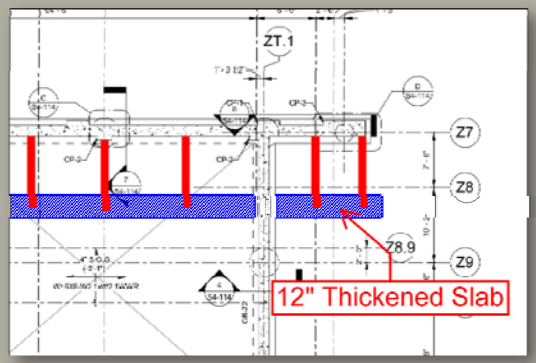
BRACING DESIGN AND LAYOUT

- **Mabey Bridge & Shore, Inc – System 160 Bracing**
  - Distribution within 20 miles of site
  - Relatively lightweight
  - Small enough not to interfere with construction
  - Favorable compressive strength
- **Bracing Layout**
  - Braces to be spaced at 10' O. C.
  - 44 total braces required (Area C: 21, Area E: 23)



BRACING DESIGN AND LAYOUT

- **Mabey Bridge & Shore, Inc – System 160 Bracing**
  - Distribution within 20 miles of site
  - Relatively lightweight
  - Small enough not to interfere with construction
  - Favorable compressive strength
- **Bracing Layout**
  - Braces to be spaced at 10' O. C.
  - 44 total braces required (Area C: 21, Area E: 23)
- **Additional Requirements**
  - 3' section of 12" thickened slab centered on the anchoring point of braces to prevent slab failure



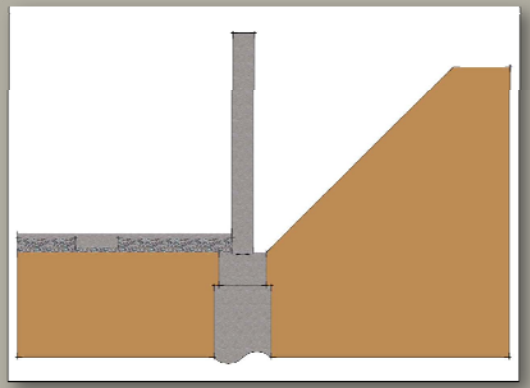
SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path

Image provided by Mabey Bridge & Shore, Inc

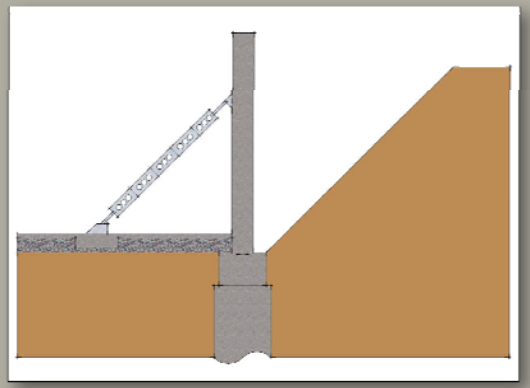
SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path
- **Construction Sequence**
  - Wall can be backfilled shortly after forms are removed
  - Grade beams in Areas C and E installed much earlier



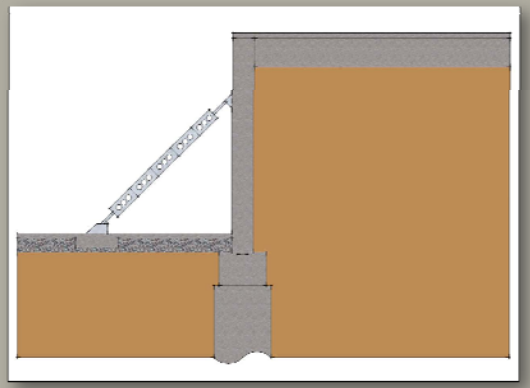
SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path
- **Construction Sequence**
  - Wall can be backfilled shortly after forms are removed
  - Grade beams in Areas C and E installed much earlier



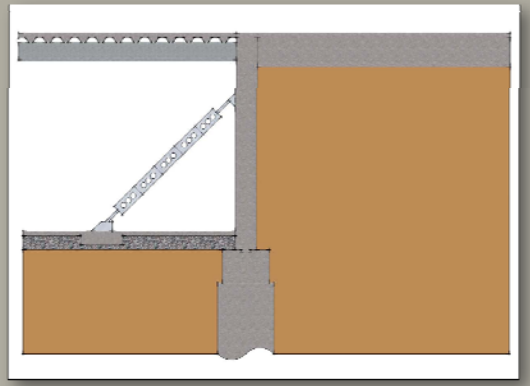
SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path
- **Construction Sequence**
  - Wall can be backfilled shortly after forms are removed
  - Grade beams in Areas C and E installed much earlier



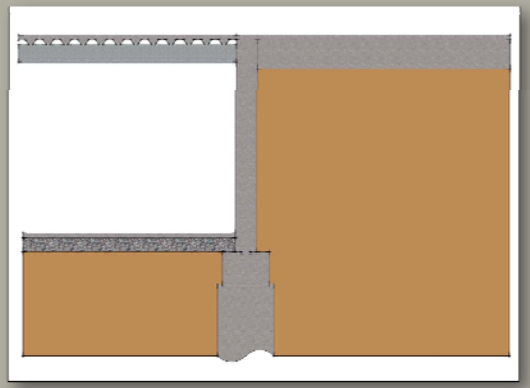
SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path
- **Construction Sequence**
  - Wall can be backfilled shortly after forms are removed
  - Grade beams in Areas C and E installed much earlier



SCHEDULE IMPACT

- **Brace Installation**
  - Must wait for slab on grade to be placed
  - Requires two man crew for installation
  - Three days required for each area
- **Schedule Change**
  - 37 day reduction in the time to complete structure
  - Potential $60,000 savings in general conditions
  - Structure lies on the critical path
- **Construction Sequence**
  - Wall can be backfilled shortly after forms are removed
  - Grade beams in Areas C and E installed much earlier



COST IMPACT

- **Brace Rental and Installation**
  - Area C (10 weeks): $11,728
  - Area E (9 weeks): $11,578
  - Installation: $1,918
- **Additional Concrete**
  - Thickened slab: $2,132
- **Total additional Cost to General Contractor**
  - **$27,356**

Original Wall Design WITH Bracing								
Caissons (3,000 psi)	286	CY	$ 97.16	$ 10.39	$ 0.41	$ 194.32	$ 123.16	$ 35,223.76
Caisson Reinforcing	11	Tons	$ 1,417.48	$ 712.64	$ -	$ 2,130.12	$ 2,714.43	$ 29,858.73
Grade Beams (4,000 psi)	119	CY	$ 101.97	$ 11.03	$ 4.90	$ 117.90	$ 133.85	$ 15,928.15
Grade Beam Reinforcing	13	Tons	$ 1,345.40	$ 413.96	$ -	$ 1,759.36	$ 2,146.73	$ 27,907.49
Concrete Walls (4,000 psi)	371	CY	$ 101.97	$ 18.07	$ 8.04	$ 128.08	$ 147.86	$ 54,856.06
Wall Reinforcing	16	Tons	$ 1,417.48	$ 497.80	$ -	$ 1,915.28	$ 2,373.83	$ 37,981.28
12" Thickened Slab Concrete	16	CY	$ 101.97	$ 10.75	$ 4.77	$ 117.49	$ 133.25	$ 2,132.00
Bracing System Labor	44	Each		$ 39.63		$ 39.63	$ 43.59	$ 1,918.09
Area C - Mabey System 160 Wall Brace Rental (21 Braces @ 10)	10	Week				$ 1,040.00	$ 1,112.80	$ 11,728.00
Area E - Mabey System 160 Wall Brace Rental (23 Braces @ 9)	9	Week				$ 1,140.00	$ 1,219.80	$ 11,578.20
							TOTAL:	$ 229,111.76

New Moon Area High School
& District Administration Offices

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- **Building Envelope Breadth / M.A.E Study**

Conclusions

Questions

ANALYSIS THREE

o **Problem**

Delays in the installation of the brick veneer resulted in additional delays in the placement of windows and curtain walls, further pushing back the building dry date.

o **Objective**

Select a precast wall system that will ensure the building enclosure remains on schedule while also adhering to the original design standards.

Image provided by Eckles Construction Services, Inc

SLENDERWALL PRECAST

- **SlenderWall Benefits**
  - Lightweight design – 30 lbs/ft^2
  - Includes 16 gauge exterior metal framing
  - Can be designed as load bearing
  - Reduced installation times with Lift-and-Release system
  - Increased floor space
  - Large variety of colors, textures and finishes available

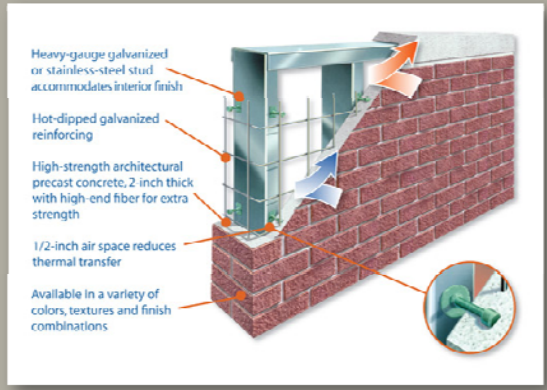
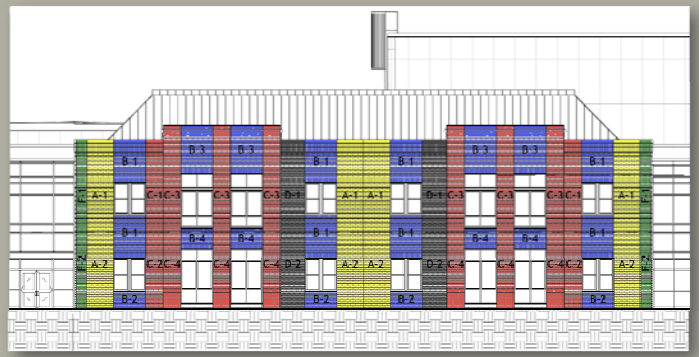


Image courtesy of SlenderWall

PANEL LAYOUT

- **Panel Sizes**
  - Building not ideally designed for precast application
  - 26 different sizes consisting of 7 different widths
  - Layout requires slight architectural changes
  - Efficiency can be increased with changes to façade details around the gymnasium and auditorium



STRUCTURAL REQUIREMENTS

- **Cavity Wall**
  - Design load 50 lbs/ft^2
  - Majority of load carried by foundation
- **SlenderWall**
  - Design load 30 lbs/ft^2
  - Can be load bearing
  - Designed to withstand differential movement
- **Conclusion**
  - Structural design will not be affected
  - Could result in overall savings if designed as load bearing

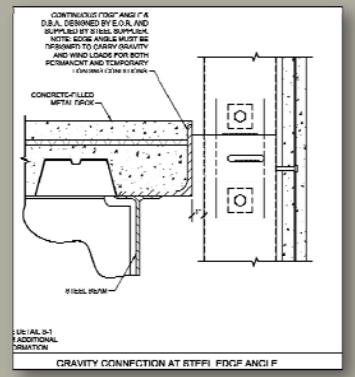
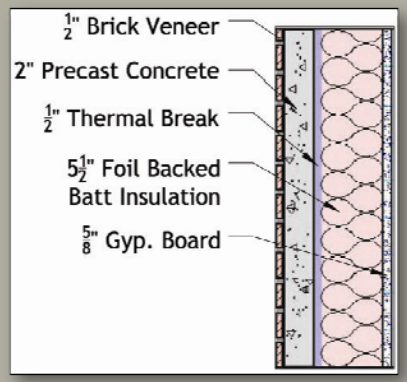


Image courtesy of SlenderWall

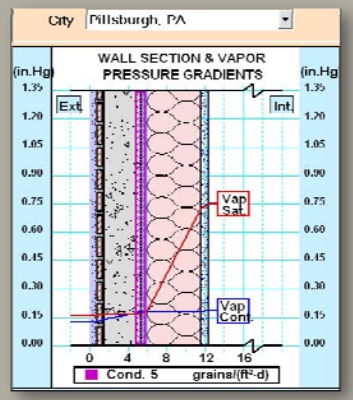
THERMAL PEFORMANCE

- **R-Value Comparison**
  - Cavity Wall: 22.086
  - SlenderWall: 22.091
- **Heat Transfer**
  - Summer
    Cavity Wall: 28,395 Btu/hr
    SlenderWall: 28,389 Btu/hr
  - Winter
    Cavity Wall: -89,554 Btu/hr
    SlenderWall: -89,534 Btu/hr
- **Conclusion**
  - The thermal performance of the SlenderWall system will not affect the design of the mechanical system.



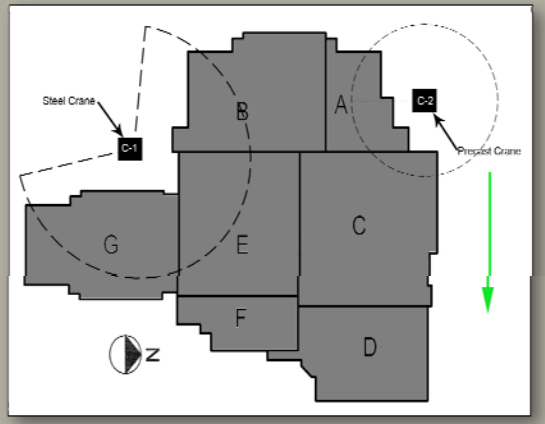
MOISTURE PERFORMANCE

- **Condensation Analysis (H.A.M. Toolbox)**
  - Cavity Wall
    Summer: No Condensation
    Winter: No Condensation
  - SlenderWall
    Summer: No Condensation
    Winter: Chance of 5 grains/(ft^2-day) in air cavity
- **Preventative Treatments**
  - Apply vapor barrier to back of studs
  - Use foil backed insulation



SCHEDULE IMPACTS

- **Installation Sequence**
  - Begin during final week of steel construction
  - Overlaps steel construction by three days
  - Start at North façade and continue clockwise
  - Lift-and-Release systems requires 20 minutes per panel



SCHEDULE IMPACTS

- **Installation Sequence**
  - Begin during final week of steel construction
  - Overlaps steel construction by three days
  - Start at North façade and continue clockwise
  - Lift-and-Release systems requires 20 minutes per panel
- **Schedule Change**
  - Original Duration: 164 days
  - SlenderWall Duration: 39 Days
  - **Difference in completion dates: -32 days**

Slenderwall Precast vs. Brick Veneer Schedule Comparison

Original Construction Schedule			
Type	**Start Date**	**Finish Date**	**Total Duration**
SlenderWall	3/10/2010	5/3/2010	39
Brick Veneer	10/29/2009	6/15/2010	164
	Total Savings:	**32 Days**	

COST IMPACT

- **Cavity Wall Cost**
  - Includes all building components not required by SlenderWall
  - Total: $2,289,946
- **SlenderWall Cost**
  - Based on average cost of $40/SF
  - Includes delivery, erection and insulation
  - Total: $2,012,912
- **Total Savings to the Owner**
  - **$277,034**

SlenderWall Precast vs. Brick Veneer Cost Comparison		
Added Material		
Material		**Cost**
SlenderWall	$	1,929,694
Foil Backed Blanket Insulation	$	83,218
Total:	**$**	**2,012,912**
Deleted Material		
Material		**Cost**
Brick Veneer	$	1,765,620.80
Extruded Polystyrene Insul.	$	123,553.60
Exterior Sheathing	$	82,368.44
Air Barrier	$	73,884.00
Exterior Metal Studs	$	244,519.74
Total:	**$**	**2,289,946.58**
Cost Savings:	**$**	**277,034.09**

CONCLUSIONS

- **Analysis One: BIM with Multiple Prime Contracts**
  - Change in contracts and specifications
  - Need owner support
  - Not ready for the change

Image provided by Eckles Architecture & Engineering, Inc

CONCLUSIONS

- **Analysis One: BIM with Multiple Prime Contracts**
  - Change in contracts and specifications
  - Need owner support
  - Not ready for the change
- **Analysis Two: Foundation Wall Bracing Design**
  - 37 day reduction in construction schedule
  - $27,356 cost to general contractor
  - More efficient construction sequence

Image provided by Mabey Bridge & Shore, Inc

CONCLUSIONS

- **Analysis One: BIM with Multiple Prime Contracts**
  - Change in contracts and specifications
  - Need owner support
  - Not ready for the change
- **Analysis Two: Foundation Wall Bracing Design**
  - 37 day reduction in construction schedule
  - $27,356 cost to general contractor
  - More efficient construction sequence
- **Analysis Three: SlenderWall Architectural Precast**
  - 32 day reduction in façade installation
  - $277,034 saving to the owner
  - Decision must be made in the beginning

Image courtesy of SlenderWall

New Moon Area High School
& District Administration Offices

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

Conclusions

Questions

ACKNOWLEDGMENTS

Eckles Construction Services, Inc.
Kenneth Holsopple
John Pappas
Brian Fulkerson

Eckles Architecture & Engineering, Inc.
Cassandra Renninger
Susan Cooper

Nello Construction
Jerry Falso

The Pennsylvania State University
Dr. Christopher Magent
Professor Holland
Professor Parfitt
Dr. Richard Behr
Craig Dubler

**New Moon Area High School &
District Administration Offices**

Barber & Hoffman Consulting Engineers
James Pospisil

Mabey Bridge & Shore, Inc.
James Porreca

Hranec Corporation
Mike Reese

W.G. Tomko, Inc.
Rich Miller

SlenderWall
Frederic Beck

. . . And most of all, I would like to THANK my family and friends!

New Moon Area High School
& District Administration Offices

Project Overview

Analysis One: BIM with Multiple Prime Contracts

Analysis Two: Foundation Wall Bracing Design

- Structural Breadth

Analysis Three: SlenderWall Architectural Precast

- Building Envelope Breadth / M.A.E Study

Conclusions

Questions

QUESTIONS?

Image provided by Eckles Architecture & Engineering, Inc