

Charles Miller
Construction Option
Spring 2009 - Dr. Riley

WestEnd25

WestEnd25



CHARLES MILLER— 2009 AE SENIOR THESIS
CONSTRUCTION OPTION - RILEY

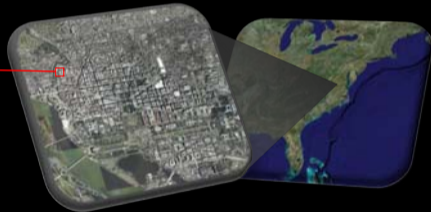
WestEnd25

Outline

- WestEnd25 Background
- Concrete Placement
- Precast Façade
- LEED
- Conclusions
- Acknowledgements
- Questions

Outline

- Project Background
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Project Background

- **Function:** Residential Apartments
- **Size:** 324,000 sq. ft. / 10 stories
- **Project Cost:** \$76 Million
- **Construction Period:** March 2007 – January 2009
- **Owner:** Vornado - Charles E. Smith
- **Contractor:** James G. Davis Construction
- **Architect:** Shalom Baranes Associates Architects

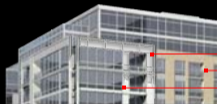
VORNADO
CHARLES E. SMITH



shalom baranes associates | architects

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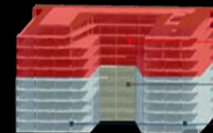


Exterior Façade:

- Metal Panels
- Brick Façade
- Curtain Wall

Project Background

- **Existing:**
 - Two 6 story office buildings
 - Precast Façade
 - Concrete Structural System
- **New Construction:**
 - One 10 story apartment building
 - Curtain wall and Brick Façade
 - Concrete Structural System



Structural Concrete Slabs:

Added Levels: 6" Post-Tensioned

Connection: 7.5" Post-Tensioned

Existing: 7.5" Conventionally Reinforced

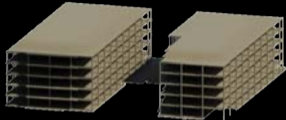
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■ **Structural System:**

■ **Existing:**

- 6 Stories Concrete



■ **New Construction:**

- 6 Connectors
- 4 Stories Concrete



Concrete Placement

■ **Placement Method:**

- Crane and Bucket

■ **Suggested Placement:**

- Concrete Pump
 - Faster Installation
 - Schedule
 - Cost



Outline

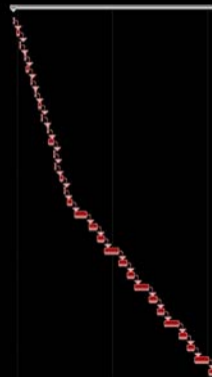
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Schedule Comparison:

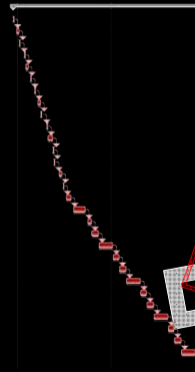
- Same Connector Slab Duration
- Pump Saves 2 Days per Full Slab

Concrete Placement

Crane and Bucket	141 days	Fri 6/27/08	Fri 1/9/09
Reinforce/Form/Place Columns to 2nd	1 day	Fri 6/27/08	Fri 6/27/08
Frame/Reinforce 2nd Flr Connector	3 days	Mon 6/30/08	Wed 7/2/08
Place 2nd Flr Connector	1 day	Thu 7/3/08	Thu 7/3/08
Reinforce/Form/Place Columns to 3rd	1 day	Tue 7/8/08	Tue 7/8/08
Frame/Reinforce 3rd Flr Connector	3 days	Wed 7/9/08	Fri 7/11/08
Place 3rd Flr Connector	1 day	Mon 7/14/08	Mon 7/14/08
Reinforce/Form/Place Columns to 4th	1 day	Fri 7/18/08	Fri 7/18/08
Frame/Reinforce 4th Flr Connector	3 days	Mon 7/21/08	Wed 7/23/08
Place 4th Flr Connector	1 day	Thu 7/24/08	Thu 7/24/08
Reinforce/Form/Place Columns to 5th	1 day	Wed 7/30/08	Wed 7/30/08
Frame/Reinforce 5th Flr Connector	3 days	Thu 7/31/08	Mon 8/4/08
Place 5th Flr Connector	1 day	Tue 8/5/08	Tue 8/5/08
Reinforce/Form/Place Columns to 6th	1 day	Wed 8/6/08	Wed 8/6/08
Frame/Reinforce 6th Flr Connector	3 days	Mon 8/11/08	Wed 8/13/08
Place 6th Flr Connector	1 day	Fri 8/15/08	Fri 8/15/08
Reinforce/Form/Place Columns to 7th	5 days	Mon 8/18/08	Fri 8/22/08
Frame/Reinforce 7th Flr	10 days	Mon 8/25/08	Fri 9/5/08
Place 7th Flr	6 days	Mon 9/8/08	Mon 9/15/08
Reinforce/Form/Place Columns to 8th	5 days	Tue 9/16/08	Mon 9/22/08
Frame/Reinforce 8th Flr	10 days	Tue 9/23/08	Mon 10/6/08
Place 8th Flr	6 days	Tue 10/7/08	Tue 10/14/08
Reinforce/Form/Place Columns to 9th	5 days	Wed 10/15/08	Tue 10/21/08
Frame/Reinforce 9th Flr	10 days	Wed 10/22/08	Tue 11/4/08
Place 9th Flr	6 days	Wed 11/5/08	Wed 11/12/08
Reinforce/Form/Place Columns to 10th	5 days	Thu 11/13/08	Wed 11/19/08
Frame/Reinforce 10th Flr	10 days	Thu 11/20/08	Wed 12/3/08
Place 10th Flr	6 days	Thu 12/4/08	Thu 12/11/08
Reinforce/Form/Place Columns to PH	5 days	Fri 12/12/08	Thu 12/18/08
Frame/Reinforce PH	10 days	Fri 12/19/08	Thu 1/1/09
Place PH	6 days	Fri 1/2/09	Fri 1/9/09



Concrete Pump	131 days	Fri 6/27/08	Fri 12/26/08
Reinforce/Form/Place Columns to 2nd	1 day	Fri 6/27/08	Fri 6/27/08
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Place 7th Flr	4 days	Mon 9/8/08	Thu 9/11/08
Reinforce/Form/Place Columns to 8th	5 days	Fri 9/12/08	Thu 9/18/08
Frame/Reinforce 8th Flr	10 days	Fri 9/19/08	Thu 10/2/08
Place 8th Flr	4 days	Fri 10/3/08	Wed 10/8/08
Reinforce/Form/Place Columns to 9th	5 days	Thu 10/9/08	Wed 10/15/08
Frame/Reinforce 9th Flr	10 days	Thu 10/16/08	Wed 10/29/08
Place 9th Flr	4 days	Thu 10/30/08	Tue 11/4/08
Reinforce/Form/Place Columns to 10th	5 days	Wed 11/5/08	Tue 11/11/08
Frame/Reinforce 10th Flr	10 days	Wed 11/12/08	Tue 11/25/08
Place 10th Flr	4 days	Wed 11/26/08	Mon 12/1/08
Reinforce/Form/Place Columns to PH	5 days	Tue 12/2/08	Mon 12/8/08
Frame/Reinforce PH	10 days	Tue 12/9/08	Mon 12/22/08
Place PH	4 days	Tue 12/23/08	Fri 12/26/08



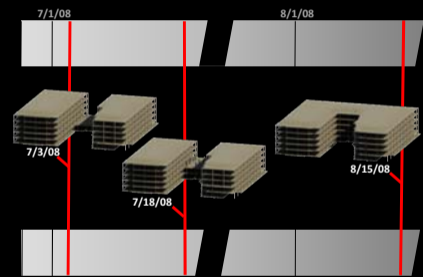
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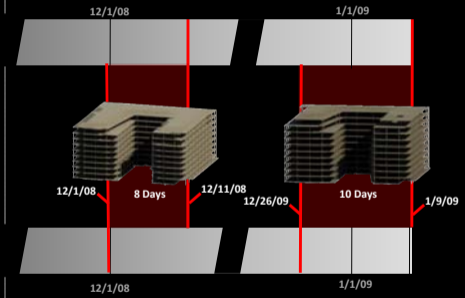
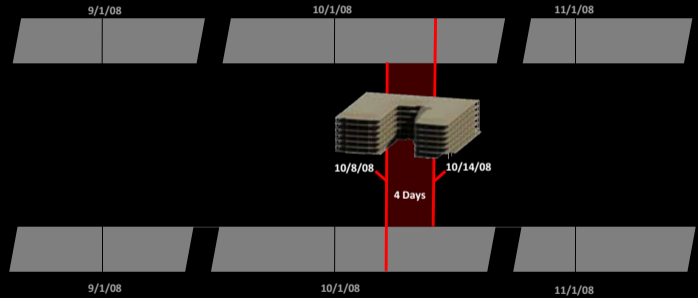
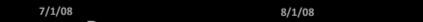
Concrete Placement

Placement Schedule Effects Timeline:

Crane and Bucket:



Pump:



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Concrete Placement

▪ Cost:

Item	Quantity	Cost Basis	Total Cost
Crane and Bucket Placement	4,106 CY	Equipment = \$7,000/week Labor = \$13/ CY	\$193,375
Pump Placement	4,106 CY	\$18.20/ CY	\$74,750
		Cost Difference	\$118,625
Supplemental Crane:		\$650/day For 131 days	(\$85,150)
		Net Savings:	\$33,475
General Conditions Savings		\$5,925/day For 10 days	\$59,250
		Total Savings:	\$92,725

- Potential savings of \$92,725
 - .12% of Project Cost

▪ Conclusion:

- Connecting Slabs Limit Efficiency
- Pump Benefits on Full Slabs
- Limited Overall Savings

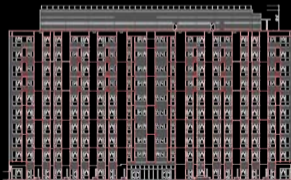
Familiar but slower method is acceptable

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Façade Analysis

- **Original Façade**
 - Precast
- **Specified Façade**
 - Brick Cavity Wall
 - Poor Slab Edges
- **Precast Façade**
 - Schedule
 - Cost
 - Thermal Performance
 - Structural Loads



Outline

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▪ Precast Benefits:

- Faster Installation
- Less Delays due to Weather

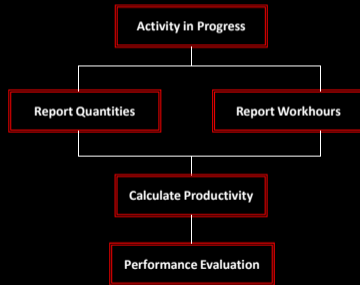
▪ Analysis Expectations

- Late Winter Weather Delays

Façade Analysis

▪ Productivity Analysis

- CE 533 – Construction Productivity Analysis and Performance Evaluation



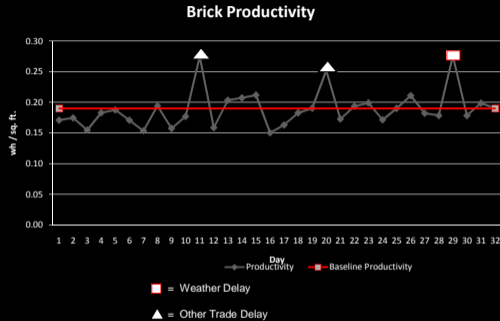
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Façade Analysis

Productivity Chart

- 3 Peaks of Decreased Productivity
 - One Weather Related
 - Two Delays from Other Trades Uncompleted Work
 - Data Point Majority Below Baseline
 - Better than Expected Productivity
-
- Analysis Shows Limited Benefits due to Weather Delays



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▪ **Brick Sequencing:**

- 1st floor North
- 1st floor East
- 1st floor South
- 2nd floor North
- 2nd floor East
- Etc...

Façade Analysis

▪ **Schedule Comparison:**



▪ **Precast Sequencing:**

- North Façade
- East Façade
- South Façade

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Façade Analysis

▪ Cost:

Item	Quantity	Cost Basis	Total Cost
Brick Façade	23,030 sq. ft.	Budget Estimate: Labor = \$489,000 Material Estimate = \$416,000 Equipment = \$131,250	\$1,036,250
Precast Facade	23,030 sq. ft.	\$35/sq.ft.	\$806,050
Difference:			\$230,200
Demolition Extra Work:			\$77,000
Total Savings:			\$307,200

▪ Conclusion:

- **Cost Savings Must be Weighed Against Risk of Difficult Installation**
 - Feasibility Depends on Crew

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Precast Façade:

Layer	R - Value ((hr*ft ² *°F)/Btu)
Exterior Air Film	0.17
6" Concrete	0.60
2" Rigid Insulation	10.00
5/8" Gypsum Board	0.56
Framing Cavity	9.0
1/2" Gypsum Board	0.45
Interior Air Film	0.68
Total	21.46
U-Value	0.047

Façade Analysis

- **U-Value Comparison**
 - Coefficient of Heat Transfer
 - Lower Value Better

- **Precast Option is Thermally Feasible**

Traditional Brick Façade:

Layer	R - Value ((hr*ft ² *°F)/Btu)
Exterior Air Film	0.17
4 in. Face Brick	0.80
1.5" Air Space	0.93
2" Rigid Insulation	10.00
5/8" Gypsum Board	0.56
Framing Cavity	9.0
1/2" Gypsum Board	0.45
Interior Air Film	0.68
Total	22.59
U-Value	0.044

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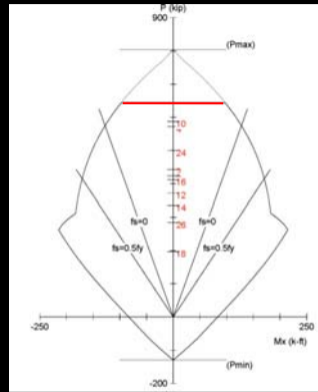
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Façade Analysis

- Structural Analysis
 - pca Column

Load	Calculation	Total
Panel	$150\text{lbs/ft}^3(.5\text{ft})(1\text{ft})(10.6\text{ft})=795\text{lbs/ftwidth}$ $795\text{lbs/ftwidth}(12\text{ftwidth})$	9,540 lbs
Concrete	$(0.625\text{ft})(150\text{lb/ft}^3)=93.75\text{lbs/ft}^2$ $93.57\text{lb/ft}^2(200\text{ft}^2)+(22.5\text{ft}^3)(150\text{lbs/ft}^3)$	22,089 lbs
Wind	$43\text{psf}(1\text{ft})(10.6)=455.8\text{lbs/ftwidth}$ $455.8\text{lbs/ftwidth}(12\text{ftwidth})$	5,469.6 lbs
Floor	$40\text{psf} + 20\text{psf} = 60\text{psf}$ $60\text{psf}(200\text{ft}^2)$	12,000 lbs

- Precast Structurally Feasible



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Façade Analysis

▪ Façade Conclusion

- Thermal Analysis and Structural Analysis Prove the Precast Façade is Feasible
- Cost Savings Must be Weighed Against Risk of Difficult Installation
 - Feasibility Depends on Crew

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LEED

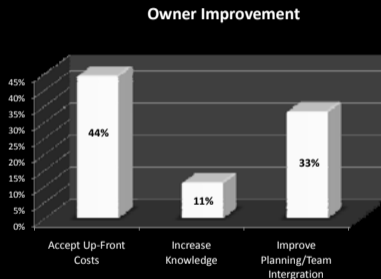
- **Critical Industry Issue: 2008 PACE Roundtable Breakout Session: LEED Evolution**
 - Increase Owner Involvement
- **Interviews of Industry Professionals**
 - Series of Open Ended Questions
 - Interesting Results

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LEED

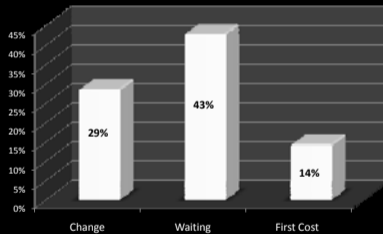
- **What do owners need to do differently?**
 - **Few Felt that Owners Need to Increase Knowledge Base**
 - **Owners Need to Accept Costs and Improve Integration**



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Owner Mistakes



LEED

- **What mistakes do owners typically make that cause problems for a project attempting a LEED Certification?**
 - **Indecisiveness is a Major Problem**
 - Owners Need to Set Clear Goals and Maintain Sustainability Commitment
 - **Indecisiveness is a Larger Problem than Accepting Costs**

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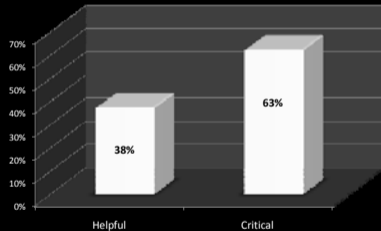
LEED

- **What do owners do that is successful and helps the overall project?**
 - **Successful Owners Clearly State Sustainability Goals and Maintain Their Commitment to Sustainability**

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Design Professional Experience

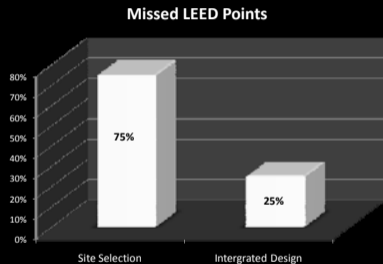


LEED

- How important is the selection of a design professional that has experience and expertise with sustainable design?
 - All Participant Indicated Importance of Sustainable Experience
 - 63% Indicated a Level of “Extreme” Importance

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LEED

- **What design decisions are typically passed over without early owner commitment to LEED?**
 - **Owners Typically Own Land Before Deciding to Build**

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LEED

- **Research Findings**
 - **Changes/Waiting Deterrent**
 - **Clear Goals and Commitment**
 - **Designer Critical**

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Summary

- **Concrete Placement**
 - Familiar but Slower Concrete Placement Method is Acceptable
- **Façade Analysis**
 - Thermal Analysis and Structural Analysis Prove the Precast is Feasible
 - Cost Savings Must be Weighted Against Risk of Difficult Installation
- **LEED**
 - Research Findings
 - Changes/Waiting Deterrent
 - Clear Goals and Commitment
 - Designer Critical

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Acknowledgments

- **Vornado/Charles E. Smith**
- **James G. Davis Construction**
- **AE Faculty**
- **Survey Participants**
- **Family & Friends**

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Questions?

