

LOYOLA INTERCOLLEGIATE
ATHLETIC COMPLEX




AE Senior Thesis 2010
Steven Rogers
Construction Management

LOYOLA INTERCOLLEGIATE ATHLETIC
COMPLEX
COLD SPRING LANE
BALTIMORE, MD 21210

OUTLINE

- Project Overview
- LEED Analysis
- Prefabricated Façade System
 - Mechanical Breadth
 - Structural Breadth
- BIM Implementation
- Recommendations
- Acknowledgements





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CLIENT INFORMATION

- Loyola University In Maryland
- New Lacrosse Stadium
- Athletic Department / Sports Teams
- Broke ground in January 2007

- **Project Overview**
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S A S A K I

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PROJECT INFORMATION

- Gross Area: 41, 520 Square Feet
- Upper and Lower Grandstands: 5, 966 people
- 4 Stories: 2 locker rooms & Offices, Concession Level, Presidential Suite & Press Boxes
- 2 Artificial Grass Fields & 1 Grass field
- 5 VRSS Slopes : 60- 110 ft Tall


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ARTIFICIAL GRASS FIELDS



VRSS-3






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Loyola IAC Costs

	Cost	Total SF	Cost/SF
Construction Cost	\$20,237,252	41,520	\$487.41
Building Cost	\$28,189,112	41,520	\$678.93
Total Project Cost	\$53,872,347	41,520	\$1297.50

SCHEDULE & COST
(3) YEAR PROJECT
\$ 54 MILLION


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OVERALL PROBLEM STATEMENT
Loyola IAC is not seeking any **LEED** rating from the US Green Build Council (USGBC).

GOAL
Demonstrate that LEED could have been achieved on this project.




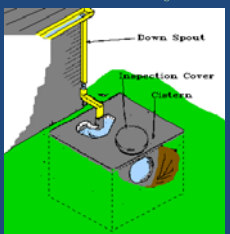
**ANALYSIS 1
LEED**



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Recycled Rubber for track and field infill






Cisterns with Reuse for Irrigation

INTERVIEW RESULTS

- Loyola
 - LEED Future
 - Schedule
 - Cost
- Example: Four Pipe System vs. PTAC
- Manpower
- Recycled Material
- Local Materials (500 mile radius)

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LEED 2009 for New Construction and Major Renovation

Sustainable Sites		Possible Points: 14
SS-1	Establish New or Restore Native Plant Species	2
SS-2	Site Selection	2
SS-3	Development Density and Community Connectivity	2
SS-4	Raw Material Sourcing	2
SS-5	Alternative Transportation: Public Transportation Access	2
SS-6	Alternative Transportation: Bicycle Storage and Changing Rooms	2
SS-7	Alternative Transportation: Low-Speed and High-Speed Vehicles	2
SS-8	Alternative Transportation: Parking Capacity	2
SS-9	Use of Landmarks, Historic or Architectural Features	2
SS-10	Use of Landmarks: Historical Open Space	2
SS-11	Stormwater Design: Quantity Control	2
SS-12	Stormwater Design: Quality Control	2
SS-13	Heat Island Effects: Cool Roof	2
SS-14	Heat Island Effects: Cool Pavement	2
SS-15	Light Pollution Reduction	2

Water Efficiency		Possible Points: 10
WE-1	Water Use Reduction: 20% Reduction	2
WE-2	Water Efficient Landscaping	2
WE-3	Reduce To 10%	2
WE-4	Reduce Water Use in Kitchens	2
WE-5	Reduce Water Use in Restrooms	2
WE-6	Water Use Reduction: 20%	2
WE-7	Water Use Reduction: 20%	2

LEED V3.0

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ALMOST HALF POINTS CAME FROM SUSTAINABLE SITES AND WATER EFFICIENCY

• 49 TOTAL POINTS – LEED CERTIFIED

• 58 POINTS POSSIBLE – LEED SILVER

Total	Possible Points: 110
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LEED CONCLUSION

- *INTERVIEWS
- *RESEARCH
- *RECOMMENDATIONS
- *LEED CERTIFIED



West & East Elevations



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ANALYSIS 2
PRECAST CONCRETE SYSTEM

OVERALL PROBLEM
STATEMENT

The hand laid brick takes a considerable amount of time to construct, takes up room with the scaffolding, and leaves room for error between trades

GOAL

To shorten the schedule, determine the added costs, calculate the added structural load, and to analyze the mechanical properties.



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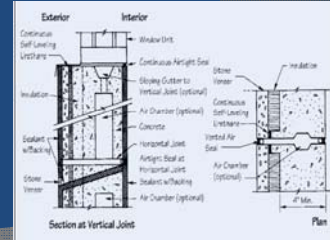


SYSTEM SELECTION

- Old Wall System
- High Concrete
- System Color



- Project Overview
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SCHEDULE

Erection Time?	21 days	49 days
Lead Time?	30 days	45 days

- Original Duration +49 days
- New Duration +21 days
- Time Savings +4 Weeks
- General Conditions Savings +\$58,912

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Activity	Duration	Start	End
112	Sitework & EXT Work	5 days	Thu 11/20/09 - Wed 11/11/10
173	Final Inspections	10 days	Tue 12/01/09 - Mon 12/01/09
174	Final Commissioning	10 days	Tue 12/01/09 - Mon 12/01/09
175	Substantial Completion	0 days	Tue 12/02/09 - Tue 12/02/09
176	Final Building Clean	8 days	Thu 12/04/09 - Mon 12/07/09
177	Final Punchlist	20 days	Thu 12/04/09 - Wed 12/09/10
178	Owner Training	5 days	Tue 12/01/10 - Mon 1/11/11
179	Occupancy	0 days	Tue 2/02/10 - Tue 2/02/10
Phase 3-Final Completion 63 days Thu 11/19/09 Tue 2/02/10			
171	Sitework & EXT Work	5 days	Thu 11/19/09 - Wed 11/11/10
172	Final Inspections	10 days	Tue 12/01/09 - Mon 12/01/09
173	Final Commissioning	10 days	Mon 11/23/09 - Mon 11/23/09
174	Substantial Completion	0 days	Mon 11/23/09 - Mon 11/23/09
175	Final Building Clean	8 days	Tue 11/24/09 - Thu 12/03/09
176	Final Punchlist	20 days	Fri 12/04/09 - Thu 12/03/10
177	Owner Training	5 days	Mon 1/11/10 - Fri 1/15/10
178	Occupancy	0 days	Tue 2/02/10 - Tue 2/02/10



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Cost of system?	\$45.64/SF, which includes material, crane costs, and installation costs.	\$17.22, which includes split face CMU and labor.
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COST

- 27,713 SF of Façade
- Cost Comparison
- Savings
- Cost Summary

- Project Overview
- LEED Analysis
- **Prefabricated Façade System**
- Mechanical Breadth
- Structural Breadth
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System Type	Cost/SF	Total Cost
Prefabricated System	\$45.64	\$1,264,821
Hand Laid Brick	\$17.22 (From Contract)	\$477,250
	\$ Difference	\$787,571
	% Difference of Building Façade	165.7%
	% Difference of Total Project Cost	1.6%

Summary	
Total Added Cost of system	\$787,571
Total of Credits and General Conditions	\$99,677
Total Cost	\$687,894
Total % Difference of Building Façade	144%
Total % Difference of Total Project Cost	1.27%



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**MECHANICAL BREADTH
INTRODUCTION**

- Goal
- U-Value
- Parallel Material Calculation Method
- R-Value
- Heat Transfer

- Project Overview
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- Mechanical Breadth**
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Original Layers	R-Value (hr x ft ² x °F)/BTU
Exterior Air Film	.17
4" Face Brick	.8
1.5" Air Space	.93
2" Rigid Insulation	10
5/8" Gypsum Board	.56
Framing Cavity	9
1/2" Gypsum Board	.45
Interior Air Film	.68
Total	22.58
U-Value	.044

R & U-VALUES

- Original
- Precast Concrete System

- Project Overview
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Precast Concrete Layers	R-Value (hr x ft ² x °F)/BTU
Exterior Air Film	.17
12" Concrete	56
2" Batt Insulation	12
Interior Air Film	.68
5/8" Gypsum Board	.56
Framing Cavity	9
1/2" Gypsum Board	.45
Total	23.82
U-Value	.042



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Estimated Heat Gain (Summer)	U-Value (BTU/hr*SF*°F)	Area (SF)	ΔT (°F)	Heat Loss (BTU/hr)
Prefabricated Split Face System	.042	10,296	22	9513.5
Original Split Face Façade	.044	10,296	22	9966.5
			Difference	453
			Reduction in Heat Gain	4.5%

Estimated Heat Loss (Winter)	U-Value (BTU/hr*SF*°F)	Area (SF)	ΔT (°F)	Heat Loss (BTU/hr)
Prefabricated Split Face System	.042	10,296	60	25945.9
Original Split Face Façade	.044	10,296	60	27181.4
			Difference	1235.5
			Reduction in Heat Loss	4.5%

COMPARISONS

- Heat Gain
 - $H = A \times U \times \Delta T$
- Heat Loss
 - $H = A \times U \times \Delta T$
- Overall Reduction
- Different ΔT for heat gain and heat loss

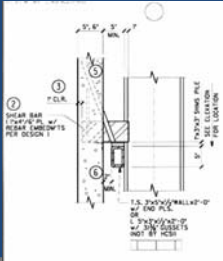
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Summer Temperatures	
T _a	8
T _i	93 (95.6%)
T _e	71
ΔT	22

Winter Temperatures	
T _a	8
T _i	11 (99.6%)
T _e	71
ΔT	60



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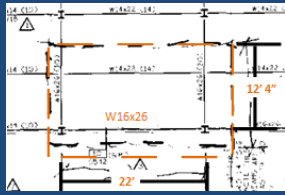
STRUCTURAL BREADTH INTRODUCTION

- Goal
- Existing Loads
- Connection Details
- Hand Calculations
- Redesign

- Project Overview
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EXTERIOR BEAM CALCULATION

- Design
- $\phi M_n > M_u$
- Total Design Load
- M_u
- M_{total}
- Redesign
- Hand Calculations

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Beam Shear and Moment Calculations

$$120 + 16L = 12(61) + 16(109) = 2156 \text{ psf}$$

$$215.6 \times (7.25 + 12.25) = 385 \text{ kips}$$

$$\frac{385}{19.5'} = 19.5 \text{ kips/ft}$$


Support Reactions = 19.5 kips by symmetry. $\Delta V_{max} = 19.5 \text{ kip}$
 $M_u = M_{dead} + S_{psf}(l)$ (for simply supported beams & point loads)
 $M_u = 19.49 \text{ kips} \times 7'4" = 142.86 \text{ kip ft}$

Load due to Exterior Brick Façade:
 Brick Weight: 40 psf Story Height: 14'
 Distributed Load = DL Safety Factor * Brick Weight * Story height
 $= 1.2 \times 40 \times 14' = 672 \text{ plf}$

For simply supported beam with distributed load:
 $M_{max} = \left(\frac{\text{dist. load} \times \text{Beam length}^2}{8} \right)$
 $M_{total} = \left(\frac{672 \times 22^2}{8} \right)$
 $= 40.66 \text{ kip ft}$

$M_{total} = 142.86 + 40.66 = 183.52 \text{ kip ft}$
 For W16x26: $M_{total} > \phi M_n = 149.8 \text{ kip ft} > 183.52$
 For W16x31: $M_{total} < \phi M_n = 203.8 \text{ kip ft} < 183.52$

*Resize this beam to W16x31, similar to beam between column lines 4 and 5.



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Exterior Column:
 $KL = 1 \cdot 14 = 14$ (column sizing from AISC manual)
 Live Load Reduction for Calculation 1:
 $LL_r = LL \left(25 + \frac{15}{\sqrt{K_{LL} \times A_f}} \right)$
 $LL_r = 100 \left(25 + \frac{15}{\sqrt{4 \times 271 \times 3}} \right)$
 $LL_r = 100 \cdot 51$ ($51 > 40$ ok)
 $LL_r = 92.3$ psf

Axial Loading Calculations for W12x79:
 $1.2D + 1.6L = 1.2(61) + 1.6(92.3) = 220.88$ psf
 Axial Load = Tributary Area \cdot Load
 $Axial\ Load = \left(\frac{271}{floor} \cdot 3\ floors \right) \cdot 220.88$ psf
 $= 179.6$ kips (excluding the facade)
 $Axial\ Load_{facade} = \left(\frac{293.3}{floor} \cdot 3\ floors \right) \cdot 70$ psf
 $= 61.6$ kips
 Total Axial Load $= 179.6 + 61.6 = 241.2$ kips
 $\phi_c P_n = 436$ kips > 241.2 kips $\Rightarrow P_n$ ok


EXTERIOR COLUMN CALCULATION

- Design
 - $\phi_c P_u > P_u$
- Total Design Load
 - P_u
 - $\phi_c P_u$
- Hand Calculations

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PRECAST CONCRETE CONCLUSION

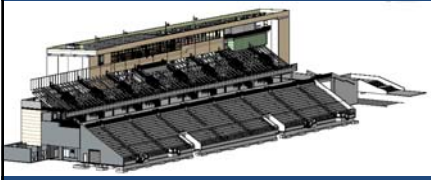
- COST & SCHEDULE
- MECHANICAL PROPERTIES
- STRUCTURAL IMPLICATIONS
- RECOMMENDATIONS



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- COST & SCHEDULE
- MECHANICAL PROPERTIES
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PRECAST CONCRETE CONCLUSION




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**ANALYSIS 3
BIM ANALYSIS**

OVERALL PROBLEM STATEMENT
Building Information Modeling (BIM) was only used on the MEP section of the project.

GOAL
To identify different programs that could be used in the BIM process, create a 4D model in Synchro, create a Virtual Design and Construction Plan, and analyze some basic upfront cost impacts.



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INTRODUCTION

- Virtual Design and Construction Plan
- Synchro
- Costs

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VIRTUAL DESIGN AND CONSTRUCTION PLAN

- *PURPOSE
- *MODELING RESPONSIBILITIES
- *COMMUNICATION
- *MODEL MANAGER

- Project Overview
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SYNCHRO

- *PROCESS
- *IMPORT 3D
- *IMPORT SCHEDULE
- *LINK TASKS TO OBJECTS
- *BENEFITS
- *INTELLIGENT MODEL
- *DECREASE RFIS
- *COORDINATION BEFORE WORK BEGINS

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Item	Cost	Qty	Total
Hardware			
42" Monitors	\$799	2	\$1,598
Additional CPU from IT Dept	\$13,200	2	\$26,400
Monitor Mounts	\$50	2	\$100
Wireless Keyboard and Mouse	\$65	1	\$65
Software			
10 year software license	\$85	1	\$85
Network Cables, Surge Protectors, etc.	\$300	1	\$300
Server Equipment	\$1,000	1	\$1,000
Services			
Project Services	\$110,000	1	\$110,000
Hardware	\$120	1	\$120
Construction Meeting Room			
Projector Screen	\$130	1	\$130
Projector Mount (ceiling)	\$45	1	\$45
Lighting	\$170	1	\$170
Lighting/Electrical work	\$1,000	1	\$1,000
Paintwork	\$440	1	\$440
Network Hand Drive for Configuration	\$70	1	\$70
Total			\$84,433

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COSTS

- *BIM ROOM
- * \$2,655
- *SOFTWARE COSTS
- *\$44,453

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BIM CONCLUSION

- *VDC PLAN
- *SYNCHRO
- *COSTS

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**OVERALL CONCLUSION
&
RECOMMENDATIONS**

- *LEED ANALYSIS
- *PREFABRICATED FAÇADE
- *BIM ANALYSIS

WHITING-TURNER
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MR. EMMETT VANRIPER

ALL MY FAMILY AND FRIENDS FOR THEIR
CONTINUED SUPPORT, ESPECIALLY MOM,
DAD, AND MY UNCLE GARRET.

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QUESTIONS?

