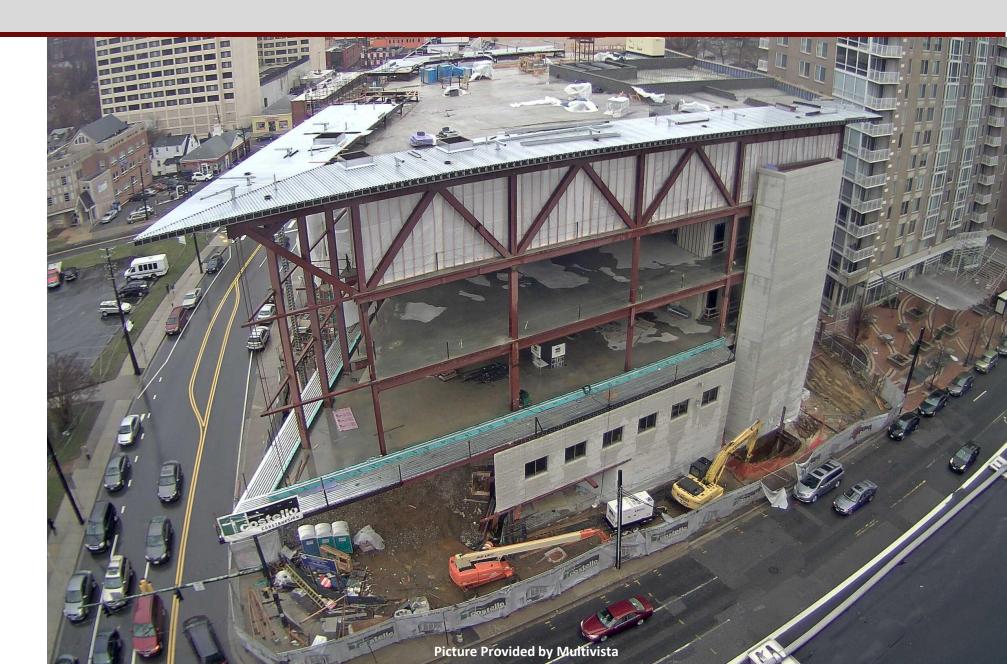


- Penn State Architectural Engineering Senior Capstone Project
 - Lowell Stine | Construction | Rob Leicht





Project Introduction Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth

Mechanical Room

Acoustical Breadth

Summary of Conclusions

Acknowledgments



Project Introduction

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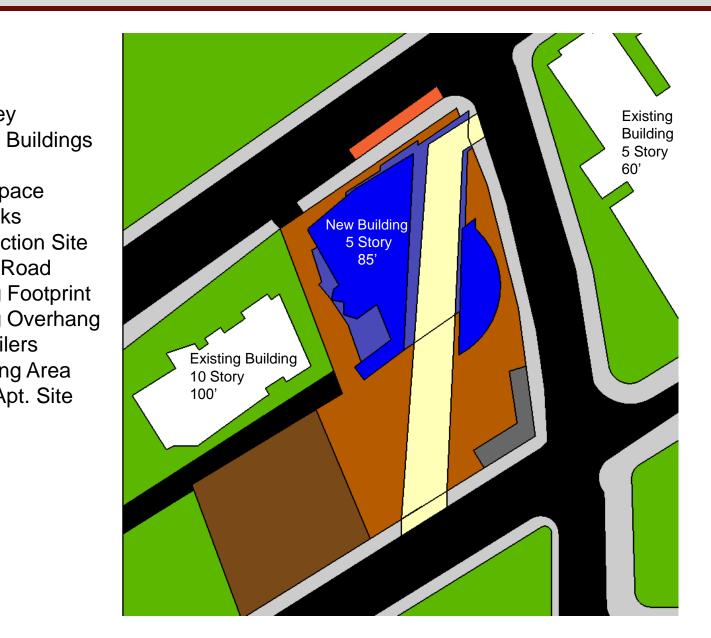




Outline Project Introduction	Building Name: Library in Metropolitan Washington, D.C. Location: Metropolitan Washington, D.C. (Undisclosed)	Key] Existing Buildir
Early Involvement	Occupant: County Library & Non-profit Art Group	Roads Open Space Sidewalks
Caisson Rebar Cage Prefab	Function Types: A-3 (Assembly)	Construction S
Structural Sequencing	B (Business) M (Mercantile)	Access Road Building Footp
Structural Breadth	Gross Area: 90,000 ft ²	Building Overh Site Trailers
Mechanical Room	Number of Stories: Five Plus Basement	Unloading Area
Acoustical Breadth Summary of Conclusions	Project Delivery: Design-Bid-Build	
Acknowledgments	Construction Dates: January 2013 – October 2014	
	Project Cost: \$69.5 Million	

Project Introduction

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Owner: Undisclosed County Construction Manager: MBP

Architect: The Lukmire Partnership Mechanical & Plumbing Engineer: Mendoza, Ribas, Farinas & Associates

Contractor: **Costello Construction**

Electrical Engineer: Mendoza, Ribas, Farinas & Associates

Structural Engineer: Columbia Engineering

IT/Security: Wright Engineering

Project Team

Civil Engineer: ADTEK

Landscape Architect: Parker Rodriguez

Interior Design: The Studio of Sandra Ragan

Lighting Consultant: MCLA

	Outline	Systems	
j	Project Introduction Early Involvement	 Architectural: 50' Cantilever of 3rd thru 5th Floors Exposed Structure in Library Space 	
	Caisson Rebar Cage Prefab	Structure: • Concrete Caissons	
	Structural Sequencing	Structural SteelComposite Slabs	
	Structural Breadth		
	Mechanical Room	 Building Enclosure: 53% Curtain Wall – UV Protection 	ŀ
	Acoustical Breadth	Terra Cotta PanelsArchitectural CMU's	
	Summary of Conclusions Acknowledgments	Mechanical:IPEC (Integrated Packages Equipment Center)	
		Hydronic In-Slab Heating	



Picture Courtesy of The Lukmire Partnership, Inc.

Project Introduction

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Picture Provided by Multivista



Picture Provided by http://www.systecon.com



4

Outline	Measurable Success	
Project Introduction	1) Minimize costs and schedule delays from change orders and rework	
Early Involvement		
Caisson Rebar Cage Prefab	2) Minimize wasted material and labor costs and limit	
Structural Sequencing	schedule delays	C EYS
Structural Breadth		
Mechanical Room	3) Shorten structural erection durations	
Acoustical Breadth	4) Cost effectiveness and fewer constructability	
Summary of Conclusions	challenges	
Acknowledgments		EE



Analysis Overview

Early Involvement in Design Research Analysis

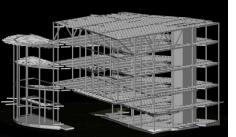
Caisson Rebar Cage Fabrication Analysis

Structural Sequencing Analysis

Structural Breadth

Mechanical Penthouse vs. IPEC Analysis

Acoustical Breadth



Programming Design

Procurement

Construction







Design

- **Building Systems**



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Early Involvement in Design Research Analysis

Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

Goal

Considerations / Requirements Specifics of this Project Typical Problem Areas

Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

Goal

Considerations / Requirements Specifics of this Project Typical Problem Areas

Industry Member Interviews

Scopes Benefits Owner Buy-in Future

Similar Topics	
Criteria	Consistency
Owner Buy-in	5 of 5
Cost Considerations	5 of 5
Scope Included	5 of 5
Relationship Outcomes	4 of 5
Quality & Project Flow	4 of 5
Schedule Considerations	4 of 5
Contract Considerations	3 of 5
Owner Involvement	3 of 5
Future of Early Involvement	3 of 5

Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

Goal

Considerations / Requirements Specifics of this Project Typical Problem Areas

Industry Member Interviews

Scopes Benefits Owner Buy-in Future

Mind Maps

Show Topics Trace Patterns

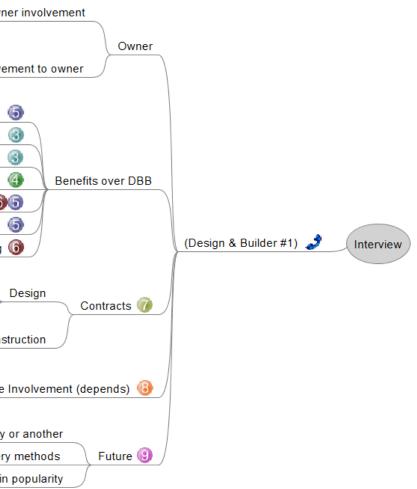
Early Involvement in Design Research Analysis

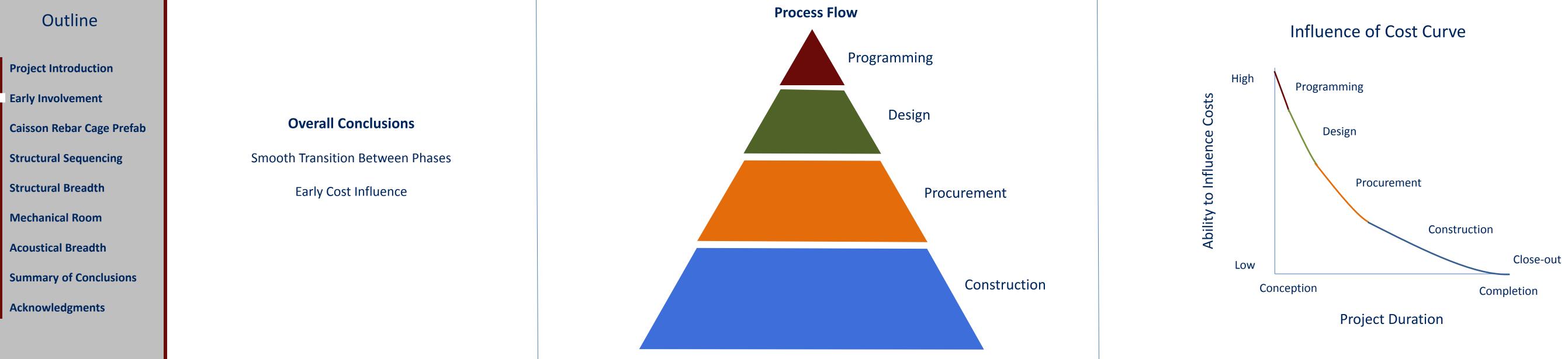
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Active - attend regular meetings 🗸 🕼
Nonactive - understaffed and not involved 🗙 Own
f done properly it should result in lower project cost
Less change orders Selling early involve
Already excepted 🙆
Specialty contractors are familiar with current and new products
Overall costs are less
Costs are locked in at about 60% design
Relationships amoung parties are positive
More value engineering opportunity ③ 🔞
Smoother purchasing phase
Allows for fast tracking
Controlling costs (budgeting)
Precon only contract
Full design and construction contracts upfront \int
Competitive bid construction contract Cons
SD - DD MEP
SD - DD Structural Scope
SD - DD Curtainwall
Every project done at Nutec is early involvement in some way
More popular because too many pit falls of other delivery
Already used widely, will grow in

Similar Topics			
Criteria	Consistency		
Owner Buy-in	5 of 5		
Cost Considerations	5 of 5		
Scope Included	5 of 5		
Relationship Outcomes	4 of 5		
Quality & Project Flow	4 of 5		
Schedule Considerations	4 of 5		
Contract Considerations	3 of 5		
Owner Involvement	3 of 5		
Future of Early Involvement	3 of 5		

Mind Maps



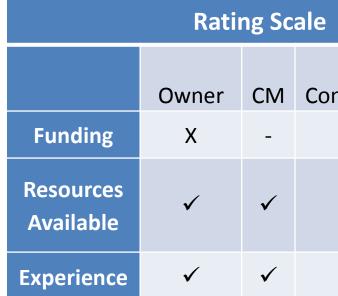


Early Involvement in Design Research Analysis



Outline			
Outime			
Project Introduction	Results	Scopes	Program
Early Involvement			
Caisson Rebar Cage Prefab	Earlier Involvement is Beneficial	Contractor	Start-up
Structural Sequencing	Less Change Orders		
Structural Breadth	Cost Savings	MEP	-
Mechanical Room	Funding Issues	Structural	_
Acoustical Breadth	Scope Selection (Project Specific)	Structural	
Summary of Conclusions		Curtain	
Acknowledgments		Wall	-

Scope Inclusion Areas					
Conceptual	Schematic Design	Design Development	Construction Documents	Construction	
Scope Selection & Sign Contract	Sub Selection & Design Input	Sub Selection & Design Input	Design Input & Long Lead Items	Management	
Planning, Questions & Sign Contract	Consult w/ Subs	Design Input	Design Input & Long Lead Items	Procurement	
-	_	Consult w/ Subs, Design Input & Sign Contract	Design Input & Long Lead Items	Procurement	
-	Consult w/ Subs & Sign Contract	Design Input	Design Input & Long Lead Items	Procurement	



		Design
CM	Contractor	Team
-	-	-
√	\checkmark	\checkmark
\checkmark	Х	\checkmark



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Caisson Rebar Cage Fabrication Analysis



Outline	Goal	
Project Introduction Early Involvement	Determine Appropriate Fabrication Method Cost Savings Scheduled Reduction	
Caisson Rebar Cage Prefab		
Structural Sequencing		
Structural Breadth		
Mechanical Room		
Acoustical Breadth		
Summary of Conclusions		
Acknowledgments		



Picture Provided by Multivista

	Outline	Goal	
	Project Introduction	Determine Appropriate Fabrication Method Cost Savings Scheduled Reduction	
	Early Involvement	Background	Туре
Ľ	Caisson Rebar Cage Prefab	Dackground	1a
	Structural Sequencing	9 Caisson Types (48 Total) Brofab to Blannod Longth	1b
	Structural Breadth	Prefab to Planned Length Planned Lengths Incorrect	2a 2b
	Mechanical Room	15 Day Delay	2c
	Acoustical Breadth		2d
			2e
	Summary of Conclusions		2f 2g
	Acknowledgments		 0

	Cais	son Ty	pes		
				Weight of	
	Qty. of			Vertical	Weight
Vertical	Vertical		# of Ties	Rebar	of Ties
Rebar #	Rebar	Tie #	per LF	(lb/LF)	(lb/LF)
9	8	4	1	27	6
9	6	4	1	20	6
11	8	4	1	43	9
11	12	4	1	64	11
11	16	4	1	85	13
11	24	4	1	128	15
11	28	5	1	149	21
11	16	4	2	85	27
11	28	5	2	149	41



| Construction

Outline	Goal	
Project Introduction	Determine Appropriate Fabrication Method Cost Savings Scheduled Reduction	
Early Involvement	Deekaround	т
Caisson Rebar Cage Prefab	Background	Ту 1
Structural Sequencing	9 Caisson Types (48 Total) Prefab to Planned Length	1
Structural Breadth	Planned Lengths Incorrect 15 Day Delay	2
Mechanical Room	10 Day Delay	2
Acoustical Breadth	Fabrication Methods	2
Summary of Conclusions	100% Planned Planed + 10%	
Acknowledgments	80% of Planned 10' Sections 15' Sections	2

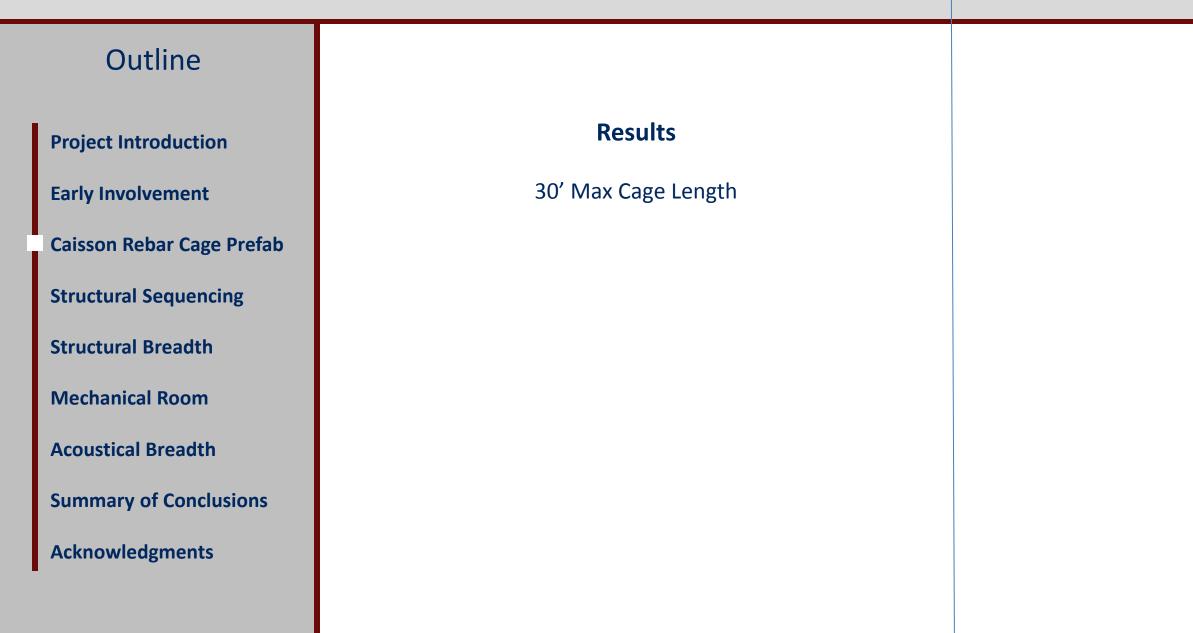
	Cais	son Ty	pes		
				Weight of	
	Qty. of			Vertical	Weight
Vertical	Vertical		# of Ties	Rebar	of Ties
Rebar #	Rebar	Tie #	per LF	(lb/LF)	(lb/LF)
9	8	4	1	27	6
9	6	4	1	20	6
11	8	4	1	43	9
11	12	4	1	64	11
11	16	4	1	85	13
11	24	4	1	128	15
11	28	5	1	149	21
11	16	4	2	85	27
11	28	5	2	149	41



Picture Provided by Multivista

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Picture Provided by www.rebarsuply.net



Outline Results **Project Introduction** 30' Max Cage Length Early Involvement Caisson Rebar Cage Prefab Truck Crane Installation Structural Sequencing Concrete Pump Placement Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

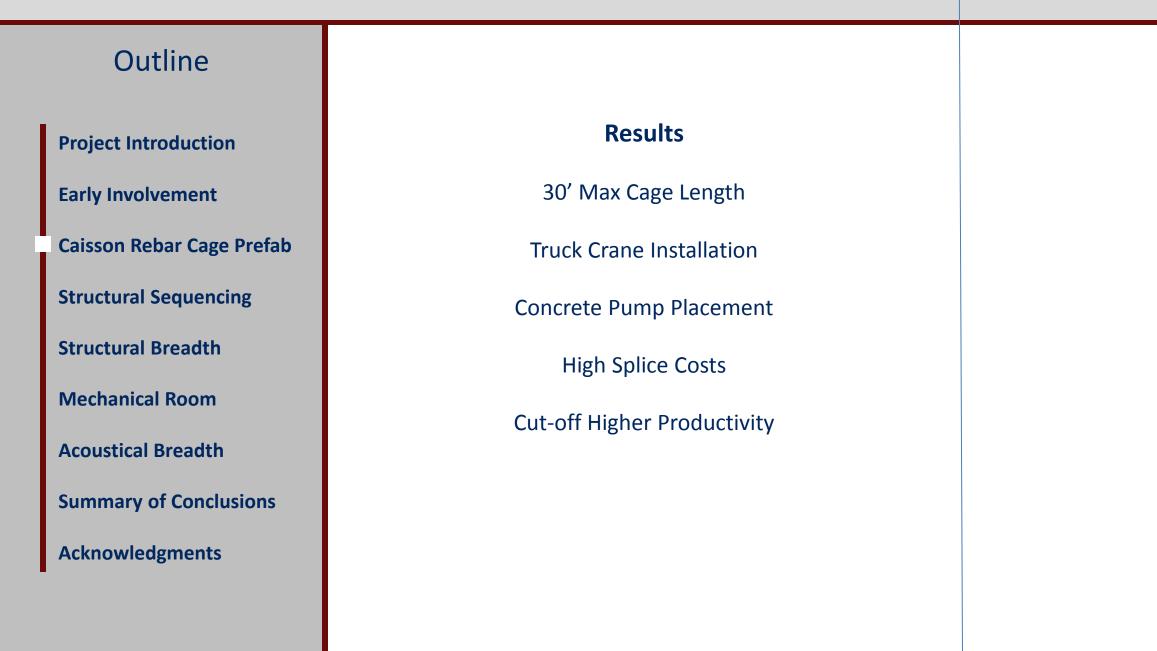


Picture Provided by www.rebarsuply.net

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Caisson Rebar Cage Fabrication Analysis



Picture Provided by http://news.thomasnet.com/



Picture Provided by www.rebarsuply.net



	Outline			
	Outilite			
	Project Introduction	Results	Caisson Types	Ba
	Early Involvement	30' Max Cage Length	1 a	\$ 1,2
ľ	Caisson Rebar Cage Prefab	Truck Crane Installation	1b	\$ 1,7
	Structural Sequencing	Concrete Pump Placement	2 a	\$ 2,3
	Structural Breadth		2b	\$ 1,8
		High Splice Costs	2c	\$
	Mechanical Room	Cut-off Higher Productivity	2d	\$ 1,5
	Acoustical Breadth	Use 100% Prefabricated Method	2e	
	Summary of Conclusions	Use 100% Prefabricated Method		\$ 12,4
	Acknowledgments	Accept Unknowns	2f	\$
			2g	\$ 1,8
			Grand Totals	\$ 22

Caisson Rebar Cage Fabrication Analysis

Prefabrication Option Comparison Over 10% Prefab Prefab 80% of 10' Length 15' Length Estimation Estimation Sections Sections lase Line \$ 2,018.26 \$ 580.70 ,207.13 \$ 2,545.31 \$ 1,040.01 \$ 2,059.49 \$ 993.63 579.61 285.71 ,756.59 S \$ 2,827.37 \$ 1,856.53 ,313.82 \$ 3,661.62 \$ 1,512.15 \$ 2,300.02 \$ 937.03 \$ 2,177.57 ,845.69 260.10 Ş \$ 2,022.40 \$ 1,011.20 \$ -,516.80 \$ 1,516.80 \$ 3,033.60 \$ 1,516.80 \$ -\$12,139.79 \$ 13,377.24 \$ 33,762.24 \$ 15,289.27 ,484.19 \$ 3,024.00 \$ 243.22 \$ 3,725.88 S --\$ 2,183.29 \$ 1,116.59 ,827.72 808.19 S \$ 32,329.00 \$ 23,402.52 \$ 51,508.23 \$ 21,723.43 \$ 22,951.94



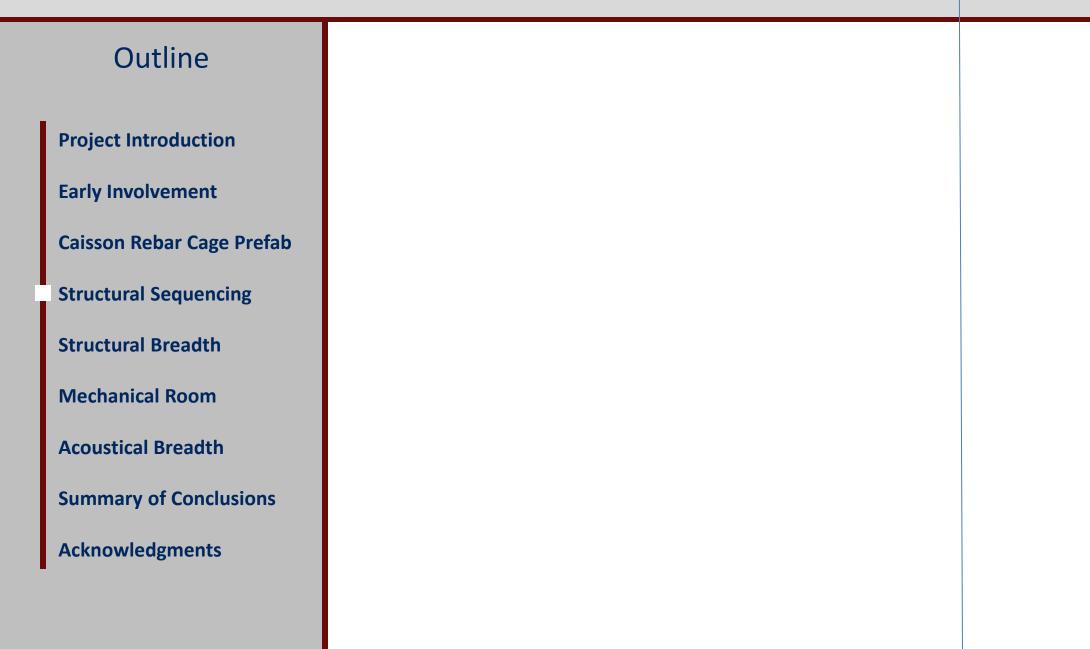
Picture Provided by http://news.thomasnet.com/



Picture Provided by www.rebarsuply.net

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Structural Sequencing Analysis



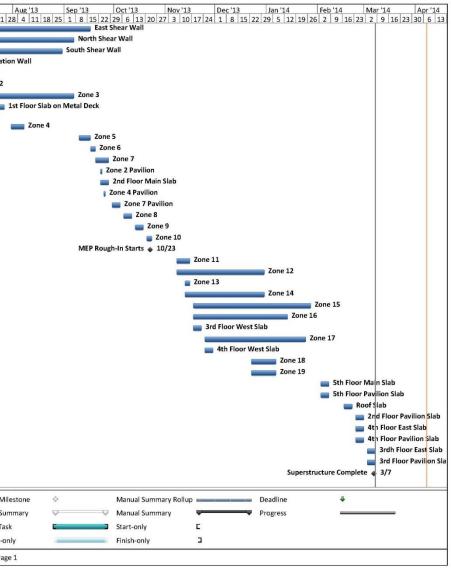
Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room Acoustical Breadth Summary of Conclusions Acknowledgments

Goal

Reevaluate Structural Sequence Save Erection Costs Shorten Erection Schedule

Structural Sequencing Analysis

ID	Task Name	Duration	Start	Finish	3 May '13	Jun '13 J 26 2 9 16 23 3	ul '13
1	East Shear Wall	106 days	Mon 4/22/13	Mon 9/16/13		. 23 2 7 7 23 3	
2	North Shear Wall	95 days	Mon 4/29/13	Fri 9/6/13			
3	South Shear Wall	80 days	Mon 5/13/13	Fri 8/30/13			
4	Foundation Wall	31 days	Mon 5/27/13	Mon 7/8/13			Foundatio
5	Zone 1	2 days	Thu 7/4/13	Fri 7/5/13			Zone 1
6	Zone 2	2 days	Tue 7/9/13	Wed 7/10/13			Zone 2
8	Zone 3	43 days	Wed 7/10/13	Fri 9/6/13			1
28	1st Floor Slab on Metal Deck	4 days	Tue 7/23/13	Fri 7/26/13			= 1
9	Zone 4	6 days	Wed 7/31/13	Wed 8/7/13			
11	Zone 5	5 days	Tue 9/10/13	Mon 9/16/13			
12	Zone 6	3 days	Tue 9/17/13	Thu 9/19/13			
13	Zone 7	6 days	Fri 9/20/13	Fri 9/27/13			
7	Zone 2 Pavilion	1 day	Mon 9/23/13	Mon 9/23/13			
29	2nd Floor Main Slab	5 days	Mon 9/23/13	Fri 9/27/13			
10	Zone 4 Pavilion	1 day	Wed 9/25/13	Wed 9/25/13			
14	Zone 7 Pavilion	5 days	Mon 9/30/13	Fri 10/4/13			
15	Zone 8	5 days	Mon 10/7/13	Fri 10/11/13			
16	Zone 9	5 days	Mon 10/14/13	Fri 10/18/13			
17	Zone 10	3 days	Mon 10/21/13	Wed 10/23/13			
18	MEP Rough-In Starts	0 days	Wed 10/23/13	Wed 10/23/13			
19	Zone 11	6 days	Fri 11/8/13	Fri 11/15/13			
20	Zone 12	37 days	Fri 11/8/13	Mon 12/30/13			
21	Zone 13	3 days	Wed 11/13/13	Fri 11/15/13			
22	Zone 14	34 days	Wed 11/13/13	Mon 12/30/13			
23	Zone 15	51 days	Mon 11/18/13	Mon 1/27/14			
24	Zone 16	41 days	Mon 11/18/13	Mon 1/13/14			
31	3rd Floor West Slab	5 days	Mon 11/18/13	Fri 11/22/13			
25	Zone 17	45 days	Mon 11/25/13	Fri 1/24/14			
34	4th Floor West Slab	5 days	Mon 11/25/13	Fri 11/29/13			
26	Zone 18	11 days	Mon 12/23/13	Mon 1/6/14			
27	Zone 19	11 days	Mon 12/23/13	Mon 1/6/14			
37	5th Floor Main Slab	5 days	Mon 2/3/14	Fri 2/7/14			
38	5th Floor Pavilion Slab	5 days	Mon 2/3/14	Fri 2/7/14			
39	Roof Slab	5 days	Mon 2/17/14	Fri 2/21/14			
30	2nd Floor Pavilion Slab	5 days	Mon 2/24/14	Fri 2/28/14			
35	4th Floor East Slab	5 days	Mon 2/24/14	Fri 2/28/14			
36	4th Floor Pavilion Slab	5 days	Mon 2/24/14	Fri 2/28/14			
32	3rdh Floor East Slab	5 days	Mon 3/3/14	Fri 3/7/14			
33	3rd Floor Pavilion Slab	5 days	Mon 3/3/14	Fri 3/7/14			
40	Superstructure Complete	0 days	Fri 3/7/14	Fri 3/7/14			
		Task	· · · · ·		Project Summary	~ ~	Inactive Mile
Prois	ti Ton-Down Schodulo	Split			External Tasks		Inactive Sum
	t: Top-Down Schedule Tue 4/8/14	Milestone			External Milestone	*	Manual Tasl
						·	
		Summary			Inactive Task		Duration-on



Outline

Project Introduction

Early Involvement

Caisson Rebar Cage Prefab

Structural Sequencing

Structural Breadth

Mechanical Room

Acoustical Breadth

Summary of Conclusions

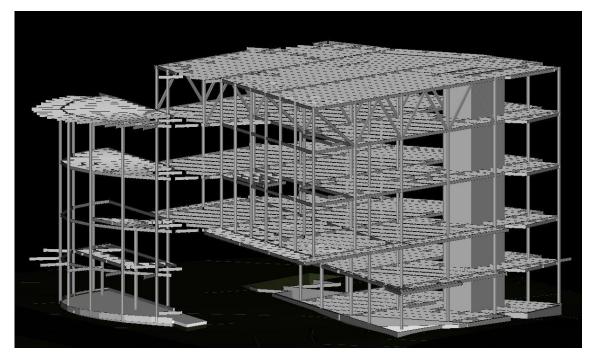
Acknowledgments

Goal

Reevaluate Structural Sequence Save Erection Costs Shorten Erection Schedule

Background Information

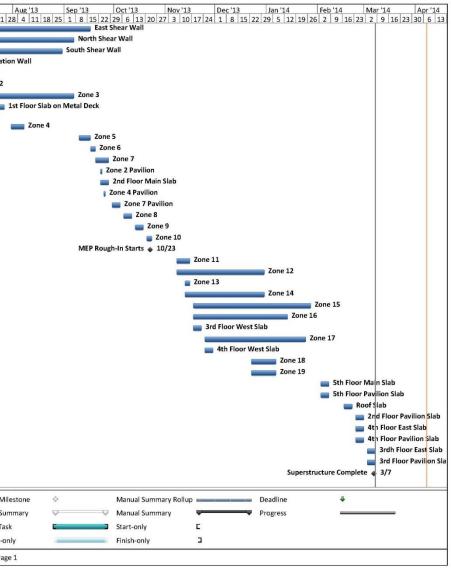
Current Erection Complex Erection Sequence 5 Week Delay



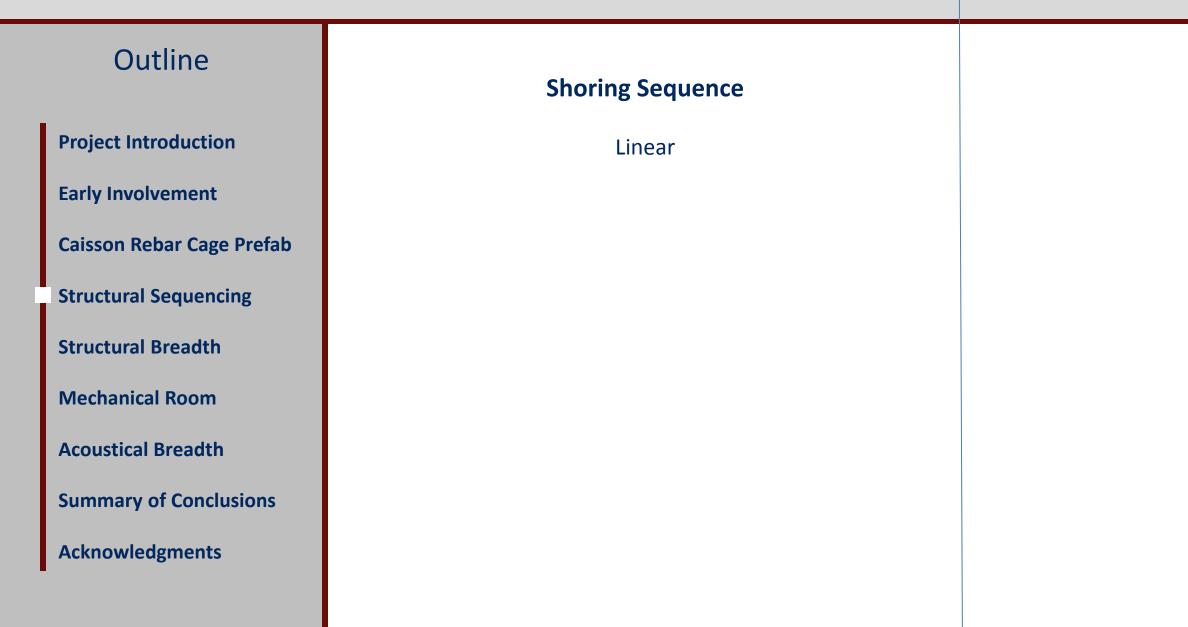
Structural Sequencing Analysis



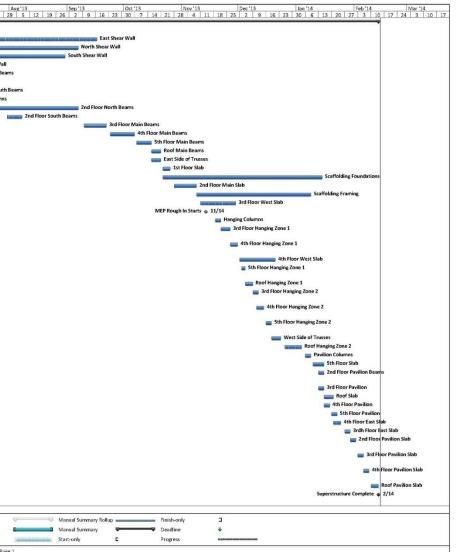
ID	Task Name	Duration	Start	Finish	B May '13	Jun '13 J 9 26 2 9 16 23 3	ul '13
1	East Shear Wall	106 days	Mon 4/22/13	Mon 9/16/13	14 21 28 5 12 1	5 20 2 9 10 23 3	0 7 14 21 2
2	North Shear Wall	95 days	Mon 4/29/13	Fri 9/6/13			
3	South Shear Wall	80 days	Mon 5/13/13	Fri 8/30/13			
4	Foundation Wall	31 days	Mon 5/27/13	Mon 7/8/13		i	Foundatio
5	Zone 1	2 days	Thu 7/4/13	Fri 7/5/13			Zone 1
6	Zone 2	2 days	Tue 7/9/13	Wed 7/10/13			Zone 2
8	Zone 3	43 days	Wed 7/10/13	Fri 9/6/13			l.
28	1st Floor Slab on Metal Deck	4 days	Tue 7/23/13	Fri 7/26/13			— 1
9	Zone 4	6 days	Wed 7/31/13	Wed 8/7/13			
11	Zone 5	5 days	Tue 9/10/13	Mon 9/16/13			
12	Zone 6	3 days	Tue 9/17/13	Thu 9/19/13			
13	Zone 7	6 days	Fri 9/20/13	Fri 9/27/13			
7	Zone 2 Pavilion	1 day	Mon 9/23/13	Mon 9/23/13			
29	2nd Floor Main Slab	5 days	Mon 9/23/13	Fri 9/27/13			
10	Zone 4 Pavilion	1 day	Wed 9/25/13	Wed 9/25/13			
14	Zone 7 Pavilion	5 days	Mon 9/30/13	Fri 10/4/13			
15	Zone 8	5 days	Mon 10/7/13	Fri 10/11/13			
16	Zone 9	5 days	Mon 10/14/13	Fri 10/18/13			
17	Zone 10	3 days	Mon 10/21/13	Wed 10/23/13			
18	MEP Rough-In Starts	0 days	Wed 10/23/13	Wed 10/23/13			
19	Zone 11	6 days	Fri 11/8/13	Fri 11/15/13			
20	Zone 12	37 days	Fri 11/8/13	Mon 12/30/13			
21	Zone 13	3 days	Wed 11/13/13	Fri 11/15/13			
22	Zone 14	34 days	Wed 11/13/13	Mon 12/30/13			
23	Zone 15	51 days	Mon 11/18/13	Mon 1/27/14			
24	Zone 16	41 days	Mon 11/18/13	Mon 1/13/14			
31	3rd Floor West Slab	5 days	Mon 11/18/13	Fri 11/22/13			
25	Zone 17	45 days	Mon 11/25/13	Fri 1/24/14			
34	4th Floor West Slab	5 days	Mon 11/25/13	Fri 11/29/13			
26	Zone 18	11 days	Mon 12/23/13	Mon 1/6/14			
27	Zone 19	11 days	Mon 12/23/13	Mon 1/6/14			
37	5th Floor Main Slab	5 days	Mon 2/3/14	Fri 2/7/14			
38	5th Floor Pavilion Slab	5 days	Mon 2/3/14	Fri 2/7/14			
39	Roof Slab	5 days	Mon 2/17/14	Fri 2/21/14			
30	2nd Floor Pavilion Slab	5 days	Mon 2/24/14	Fri 2/28/14			
35	4th Floor East Slab	5 days	Mon 2/24/14	Fri 2/28/14			
36	4th Floor Pavilion Slab	5 days	Mon 2/24/14	Fri 2/28/14			
32	3rdh Floor East Slab	5 days	Mon 3/3/14	Fri 3/7/14			
33	3rd Floor Pavilion Slab	5 days	Mon 3/3/14	Fri 3/7/14			
40	Superstructure Complete	0 days	Fri 3/7/14	Fri 3/7/14			
	·	Task	- 	_	Project Summary		Inactive Mile
.	LT D CLUL	Split	100 March 200		External Tasks		Inactive Sum
	t: Top-Down Schedule Tue 4/8/14						
Date:	100 4/0/14	Milestone	*		External Milestone	Ψ	Manual Task
		Summary			Inactive Task		Duration-on







ID	Task Name	Duration	Start	Finish	Apr'13 18 25 1	May 8 15 22 29	6 13 20 27	n'13 3 10 17 24	Jul '13 1 8
1	Shoring Sequence	319 days	Mon 4/1/13	Fri 2/14/14	ψ	1000 provide a series			
2	Excavation	19 days	Mon 4/1/13	Fri 4/19/13		Excavation			
3	East Shear Wall	148 days	Mon 4/22/13	Mon 9/16/13		1 - 11 - 11 - 11 - 11 - 11 - 11 - 11 -	annen die bie andere bie die andere die bie die annee die	And the second states and the second states and	of the second division of the local division of the
4	North Shear Wall	131 days	Mon 4/29/13	Fri 9/6/13					
5	South Shear Wall	110 days	Mon 5/13/13	Fri 8/30/13			(
6	Foundation Wall	43 days	Mon 5/27/13	Mon 7/8/13					Fo
7	1st Floor North Beams	2 days	Thu 7/4/13	Fri 7/5/13					🔳 1st F
9	North Columns	2 days	Thu 7/4/13	Fri 7/5/13	1				Nort
8	1st Floor South Beams	2 days	Tue 7/9/13	Wed 7/10/13					
10	South Columns	2 days	Tue 7/9/13	Wed 7/10/13					
11	2nd Floor North Bearns	59 days	Wed 7/10/13	Fri 9/6/13					
12	2nd Floor South Beams	8 days	Wed 7/31/13	Wed 8/7/13					
13	3rd Floor Main Beams	12 days	Tue 9/10/13	Sat 9/21/13					
14	4th Floor Main Beams	13 days	Tue 9/24/13	Sun 10/6/13					
15	5th Floor Main Beams	10000	Tue 10/8/13						
15	Roof Main Beams	8 days		Tue 10/15/13					
		5 days	Wed 10/16/13						
31	East Side of Trusses	5 days	Wed 10/16/13						
17	1st Floor Slab	4 days	Tue 10/22/13						
18	Scaffolding Foundations	85 days	Tue 10/22/13						
20	2nd Floor Main Slab	12 days	Mon 10/28/13						
19	Scaffolding Framing	61 days	Sat 11/9/13	Wed 1/8/14					
33	3rd Floor West Slab	19 days	Mon 11/11/13	Fri 11/29/13					
21	MEP Rough In Starts	0 days	Thu 11/14/13	Thu 11/14/13					
22	Hanging Columns	3 days	Tue 11/19/13	Thu 11/21/13					
23	3rd Floor Hanging Zone 1	5 days	Fri 11/22/13	Tue 11/26/13					
24	4th Floor Hanging Zone 1	4 days	Wed 11/27/13	Sat 11/30/13					
35	4th Floor West Slab	19 days	Mon 12/2/13	Fri 12/20/13					
25	5th Floor Hanging Zone 1	2 days	Tue 12/3/13	Wed 12/4/13					
26	Roof Hanging Zone 1	4 days	Thu 12/5/13	Sun 12/8/13	-				
27	3rd Floor Hanging Zone 2		Mon 12/9/13	Wed 12/11/1					
28	4th Floor Hanging Zone 2	4 days	Wed 12/11/13	Sat 12/14/13					
29	5th Floor Hanging Zone 2	3 days	Mon 12/16/13	Wed 12/18/1					
32	West Side of Trusses	5 days	Thu 12/19/13	Mon 12/23/13					
30	Roof Hanging Zone 2	9 days	Thu 12/26/13	Fri 1/3/14					
39	Pavilion Columns	3 days	Mon 1/6/14	Wed 1/8/14	-				
37	5th Floor Slab	6 days	Fri 1/10/14	Wed 1/15/14	-				
40	2nd Floor Pavilion Beams		Mon 1/13/14						
41	3rd Floor Pavilion	3 days	Mon 1/13/14	Wed 1/15/14					
38	Roof Slab	5 days	Thu 1/16/14	Mon 1/20/14					
42	4th Floor Pavilion	3 days	Thu 1/16/14	Sat 1/18/14					
43	5th Floor Pavilion	3 days	Mon 1/20/14	Wed 1/22/14					
36	4th Floor East Slab		Tue 1/21/14	Fri 1/24/14					
36		4 days							
34 44	3rdh Floor East Slab 2nd Floor Pavilion Slab	3 days 3 days	Mon 1/27/14 Thu 1/30/14	Wed 1/29/14 Sat 2/1/14					
45	3rd Floor Pavilion Slab	3 days	Mon 2/3/14	Wed 2/5/14					
45	4th Floor Pavilion Slab	3 days	Mon 2/3/14						
			0.001/2010/2010/02/0	Sat 2/8/14					
47	Roof Pavilion Slab	4 days	Mon 2/10/14	Thu 2/13/14					
48	Superstructure Complete	0 days	Fri 2/14/14	Fri 2/14/14					
		Task		_	Summary		External Milestone	Ŷ	Inactive
	ct: Shoring Sequence Schedu Tue 4/8/14	Split			Project Summary		Inactive Task	L	Manua
Sere.	100 1101 14	Milestone			External Tasks		Inactive Milestone	0	Duratio

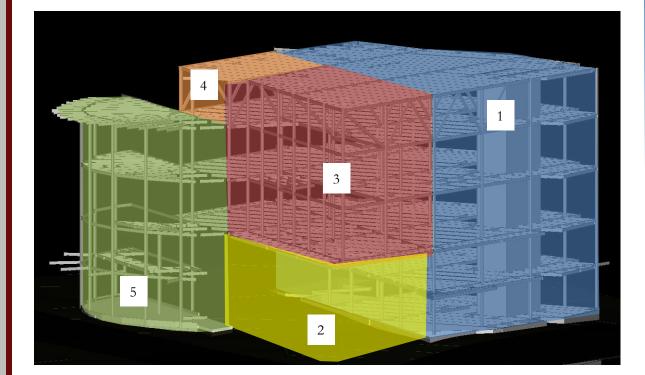




Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

Shoring Sequence

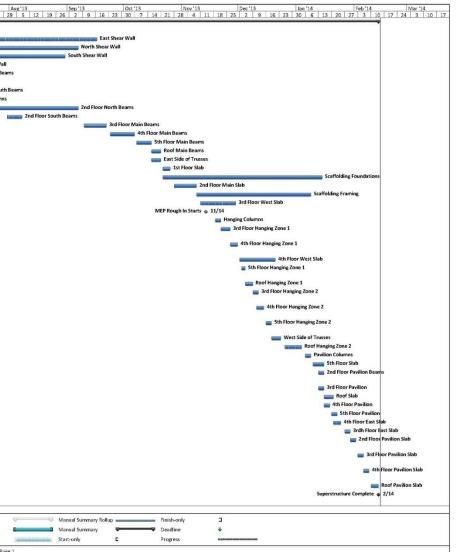
Linear 4-D Comparisons Slabs After Shoring Hanger Resizing?



Structural Sequencing Analysis



D	Task Name	Duration	Start	Finish	Apr'13 18 25 1	May'	13 Jun 6 13 20 27		Jul'13 4 1 8 1
1	Shoring Sequence	319 days	Mon 4/1/13	Fri 2/14/14		10 EE 20	10 10 27		
2	Excavation	19 days	Mon 4/1/13	Fri 4/19/13		Excavation			
3	East Shear Wall	148 days	Mon 4/22/13	Mon 9/16/13			and the property line and property line and pro-	AND PERSONAL PROPERTY AND PERSONNEL PROPERTY.	the last descent list and descent part with w
4	North Shear Wall	131 days	Mon 4/29/13	Fri 9/6/13					
5	South Shear Wall	110 days	Mon 5/13/13	Fri 8/30/13			2		
6	Foundation Wall	43 days	Mon 5/27/13	Mon 7/8/13					Found
7	1st Floor North Beams	2 days	Thu 7/4/13	Fri 7/5/13					Ist Floo
9	North Columns	2 days	Thu 7/4/13	Fri 7/5/13					North C
8	1st Floor South Beams	2 days	Tue 7/9/13	Wed 7/10/13					1st
10	South Columns	2 days	Tue 7/9/13	Wed 7/10/13					Sou
11	2nd Floor North Beams	59 days		Fri 9/6/13	-				
12	2nd Floor South Beams	8 days	Wed 7/31/13	Wed 8/7/13					-
13	3rd Floor Main Beams	12 days	Tue 9/10/13	Sat 9/21/13					
14	4th Floor Main Beams	13 days	Tue 9/24/13	Sun 10/6/13					
14	5th Floor Main Beams	8 days	Tue 10/8/13	Tue 10/15/13	-				
15	Roof Main Beams	5 days	Wed 10/16/13		-				
31	East Side of Trusses	5 days 5 days	Wed 10/16/13 Wed 10/16/13						
17	1st Floor Slab	4 days							
17	Scaffolding Foundations	4 days 85 days	Tue 10/22/13 Tue 10/22/13		-				
	-								
20 19	2nd Floor Main Slab Scaffolding Framing	12 days 61 days	Mon 10/28/13 Sat 11/9/13	Wed 1/8/13					
19 33									
	3rd Floor West Slab	19 days	Mon 11/11/13						
21	MEP Rough In Starts	0 days	Thu 11/14/13		-				
22	Hanging Columns	3 days	Tue 11/19/13						
23	3rd Floor Hanging Zone 1	5 days	Fri 11/22/13	Tue 11/26/13					
24	4th Floor Hanging Zone 1	4 days	Wed 11/27/13	Sat 11/30/13					
35	4th Floor West Slab	19 days	Mon 12/2/13	Fri 12/20/13					
25	5th Floor Hanging Zone 1		Tue 12/3/13	Wed 12/4/13					
26	Roof Hanging Zone 1	4 days	Thu 12/5/13	Sun 12/8/13					
27	3rd Floor Hanging Zone 2	3 days		Wed 12/11/1	6				
28	4th Floor Hanging Zone 2	4 days	Wed 12/11/13	Sat 12/14/13					
29	5th Floor Hanging Zone 2	3 days	Mon 12/16/13	Wed 12/18/1					
-									
32	West Side of Trusses	5 days	Thu 12/19/13						
30	Roof Hanging Zone 2	9 days		Fri 1/3/14					
39	Pavilion Columns	3 days	Mon 1/6/14	Wed 1/8/14					
37	5th Floor Slab	6 days	Fri 1/10/14	Wed 1/15/14					
40	2nd Floor Pavilion Beams	3 days	Mon 1/13/14	Wed 1/15/14					
41	3rd Floor Pavilion	3 days	Mon 1/13/14	Wed 1/15/14					
38	Roof Slab	5 days	Thu 1/16/14	Mon 1/20/14					
42	4th Floor Pavilion	3 days	Thu 1/16/14	Sat 1/18/14					
43	5th Floor Pavilion	3 days	Mon 1/20/14	Wed 1/22/14					
36	4th Floor East Slab	4 days	Tue 1/21/14	Fri 1/24/14					
34	3rdh Floor East Slab	3 days		Wed 1/29/14					
44	2nd Floor Pavilion Slab	3 days	Thu 1/30/14	Sat 2/1/14					
45	3rd Floor Pavilion Slab	3 days	Mon 2/3/14	Wed 2/5/14					
46	4th Floor Pavilion Slab	3 days	Thu 2/6/14	Sat 2/8/14					
47	Roof Pavilion Slab	4 days	Mon 2/10/14	Thu 2/13/14					
47	Superstructure Complete		Fri 2/14/14	Fri 2/14/14					
Projer	t: Shoring Sequence Schedu	Task	-		Summary		External Milestone	٠	Inactive Sur
Date:	Tue 4/8/14	Split			Project Summary	\$ \$	Inactive Task	L	Manual Tas
		Milestone	•		External Tasks	west with the line strainer and pictures and	Inactive Milestone	0	Duration-or





Outline	Complexity of Erection
Project Introduction	Complex structure Inconsistent erection sequence
Early Involvement	
Caisson Rebar Cage Prefab	
Structural Sequencing	
Structural Breadth	
Mechanical Room	
Acoustical Breadth	
Summary of Conclusions	
Acknowledgments	

Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

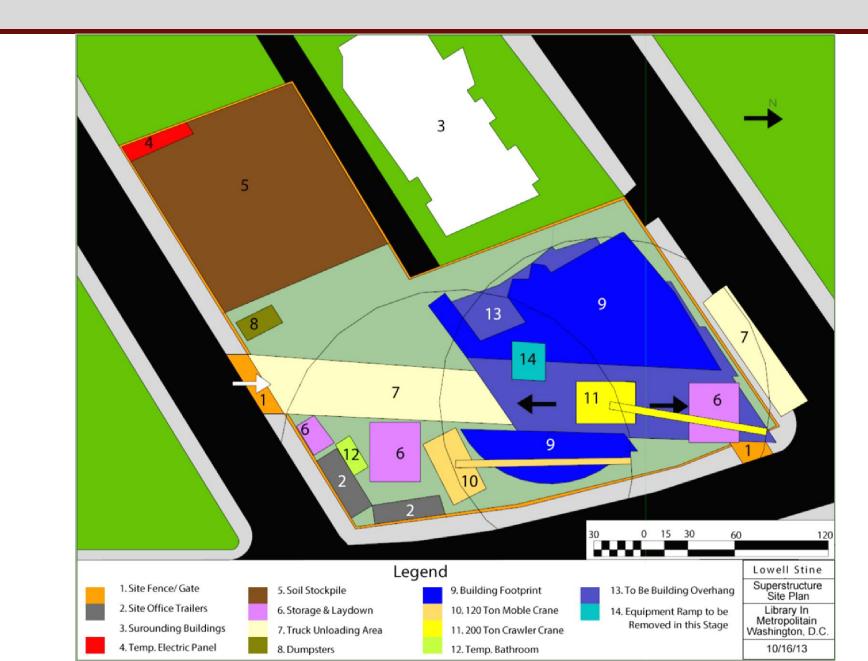
Complexity of Erection

Complex structure Inconsistent erection sequence

Site

Very urban site Shoring will occupy large area Tight delivery scheduling

Structural Sequencing Analysis



Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room Acoustical Breadth Summary of Conclusions Acknowledgments

Complexity of Erection

Complex structure Inconsistent erection sequence

Site

Very urban site Shoring will occupy large area Tight delivery scheduling

Safety

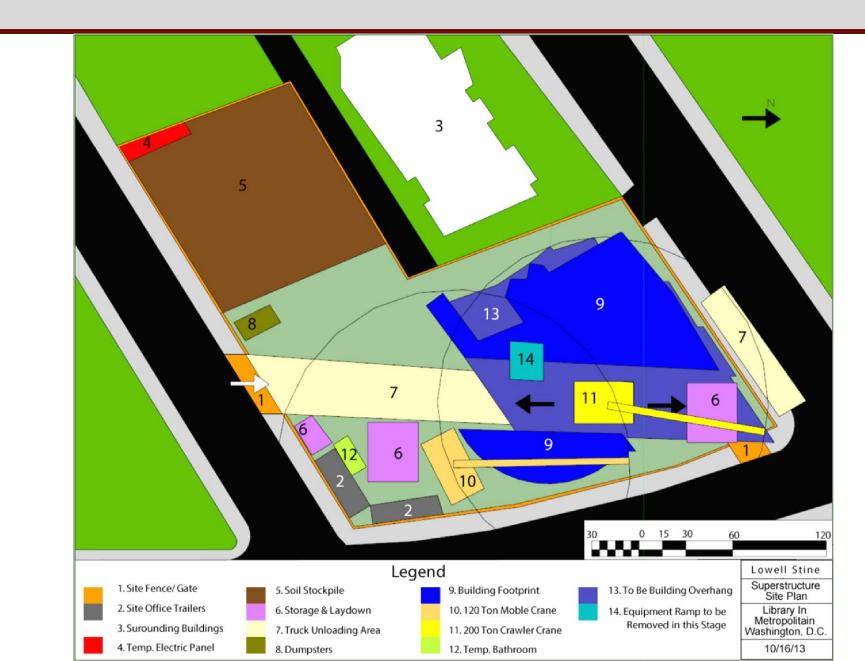
High priority Dangerous welding locations OSHA compliance



Structural Sequencing Analysis

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Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room Acoustical Breadth Summary of Conclusions Acknowledgments

Complexity of Erection

Complex structure Inconsistent erection sequence

Site

Very urban site Shoring will occupy large area Tight delivery scheduling

Safety

High priority Dangerous welding locations OSHA compliance

Trade Integration

Delay of MEP rough-in start-up

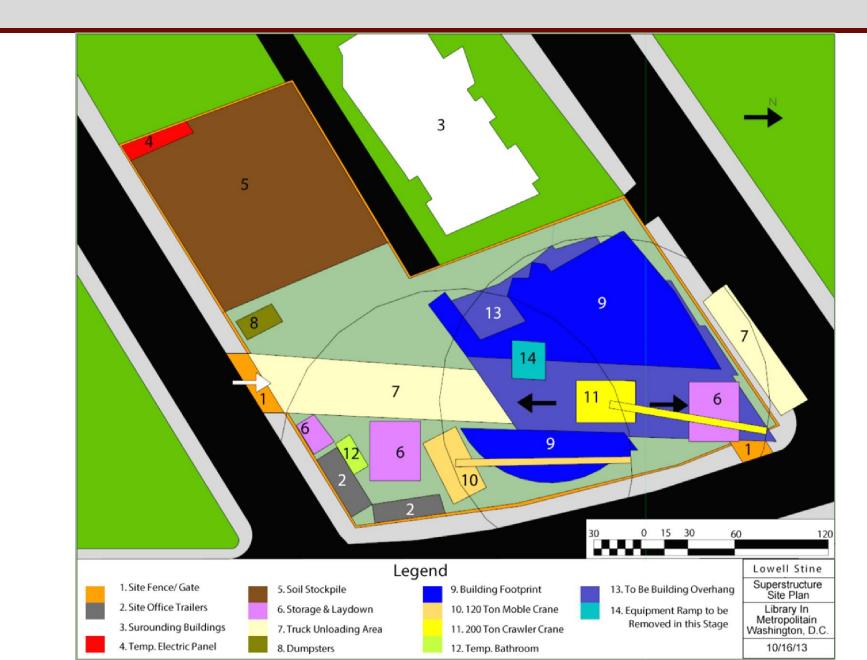


Structural Sequencing Analysis

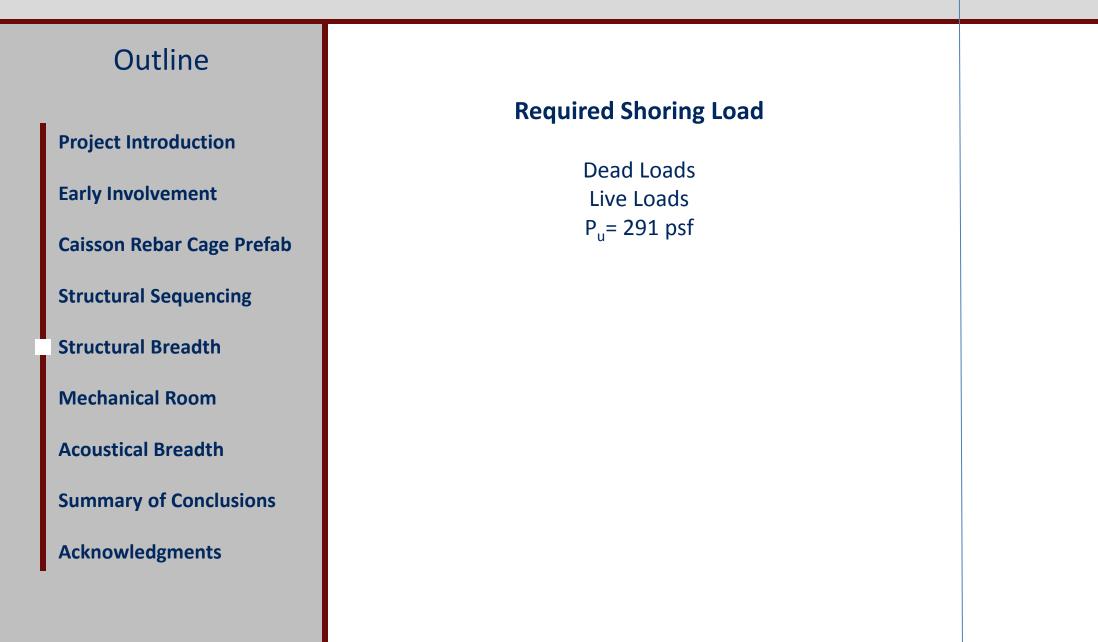
MEP Rough-in Sta	rt Dates	
Description	Top-Down	Shoring
Description	Option	Option
MEP Rough-in Start	10/23/13	11/14/13



Picture Provided by Multivista



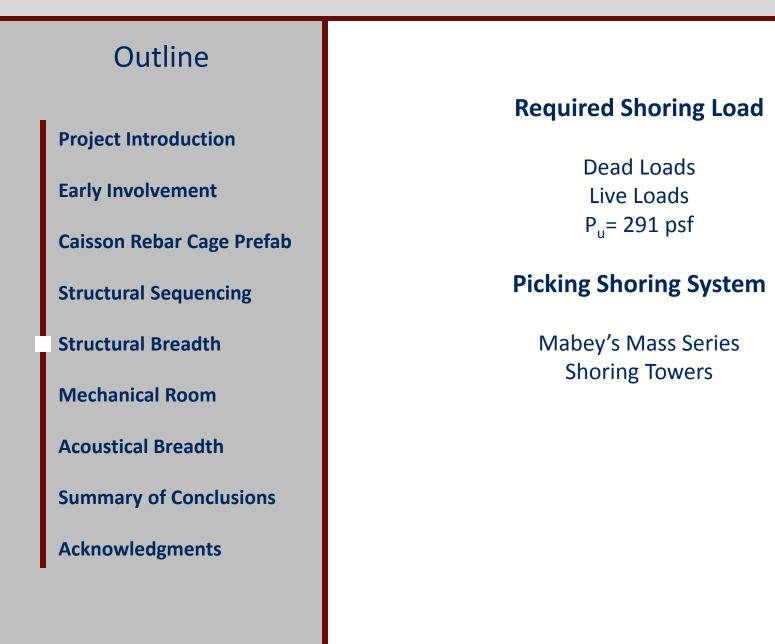




$$L = L_0 \times \begin{cases} 0.4 \\ 0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \end{cases}$$

$P_u = 1.2D + 1.6L$





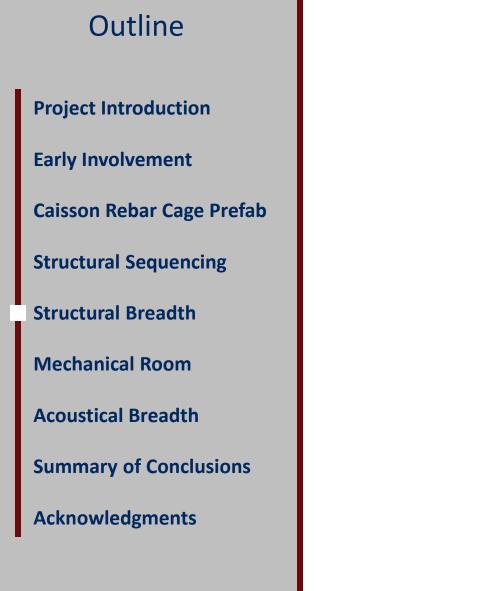


Picture Provided by Mabey Inc.



$$L = L_0 \times \begin{cases} 0.4 \\ 0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \end{cases}$$

$P_u = 1.2D + 1.6L$



Required Shoring Load

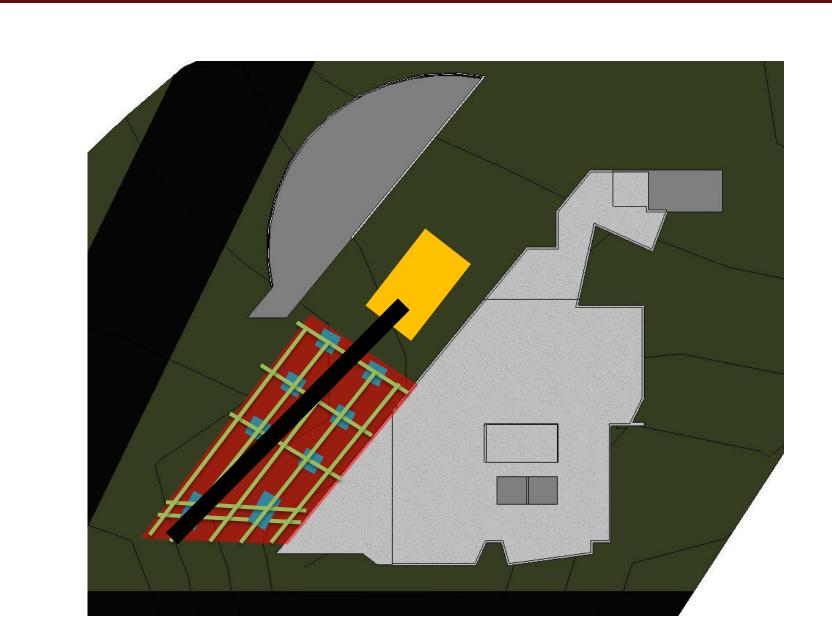
Dead Loads Live Loads P_u= 291 psf

Picking Shoring System

Mabey's Mass Series Shoring Towers

Finalize Shoring Design

Mass 25 - 100 kips Space at 20'x18' (16) 5'x5' & (2) 5'x10'



Structural Breadth - Shoring Design

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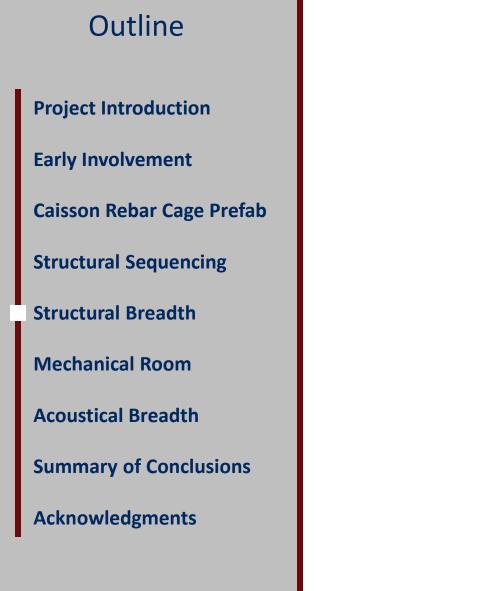


Picture Provided by Mabey Inc.



$$L = L_0 \times \begin{cases} 0.4 \\ 0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \end{cases}$$

$P_u = 1.2D + 1.6L$



Required Shoring Load

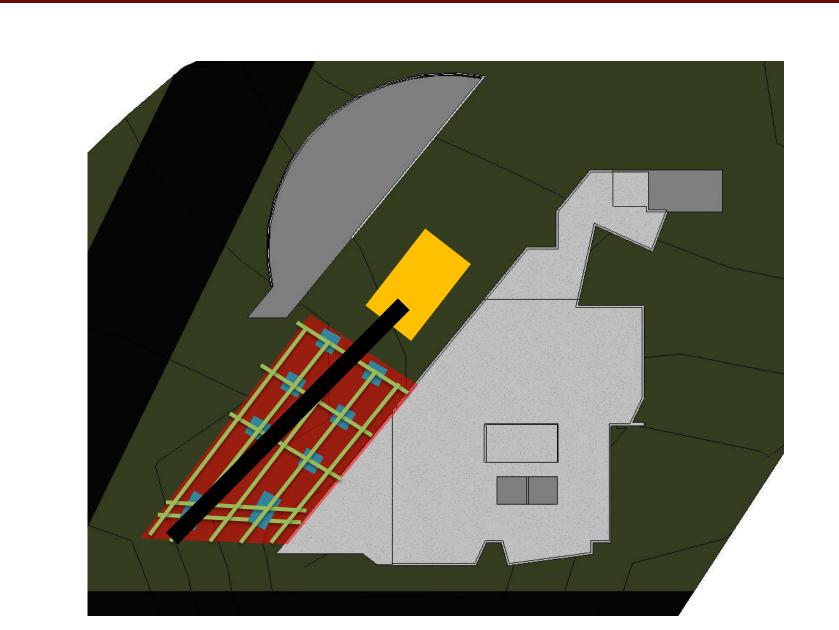
Dead Loads Live Loads P_u= 291 psf

Picking Shoring System

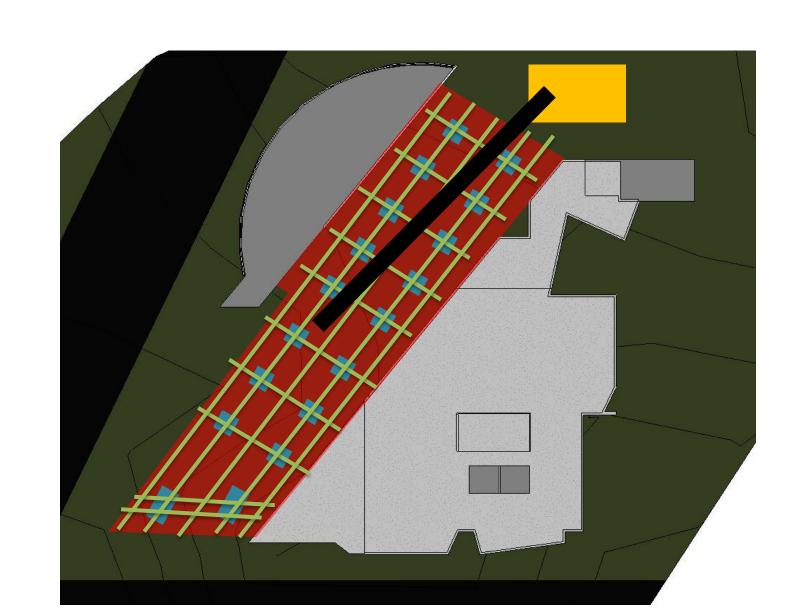
Mabey's Mass Series Shoring Towers

Finalize Shoring Design

Mass 25 - 100 kips Space at 20'x18' (16) 5'x5' & (2) 5'x10'



Structural Breadth - Shoring Design





Outline	Results
Project Introduction	3 Week Schedule Savings (with shoring install)
Early Involvement	\$30,000 Savings
Caisson Rebar Cage Prefat	Better Productivity (Specific Zones)
Structural Sequencing	Recommend the Shoring Sequence
Structural Breadth	IPEC vs. Mechanical Penthouse
Structural Breadth Mechanical Room	
	Criteria & do
Mechanical Room Acoustical Breadth	Criteria & do L do
Mechanical Room	Criteria & CategoriesdoSubConstructabilityxImage: Sub-scienceSchedulexImage: Sub-scienceCostImage: Sub-scienceImage: Sub-science
Mechanical Room Acoustical Breadth	Criteria & Categoriesdo LMuirous vousConstructabilityx✓Schedulex✓Cost✓✓Site✓×
Mechanical Room Acoustical Breadth Summary of Conclusions	Criteria & CategoriesdoSubConstructabilityxImage: Sub-scienceSchedulexImage: Sub-scienceCostImage: Sub-scienceImage: Sub-science

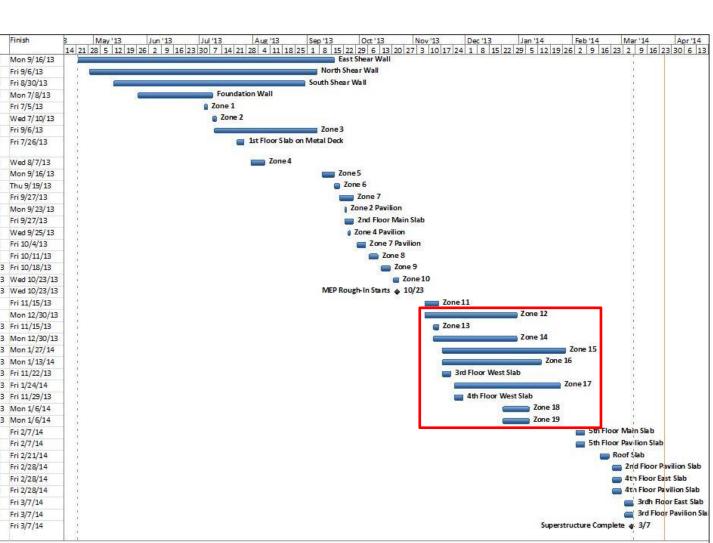
D	Task Name	Duration	Start
1	East Shear Wall	106 days	Mon 4/22/13
2	North Shear Wall	95 days	Mon 4/29/13
з	South Shear Wall	80 days	Mon 5/13/13
4	Foundation Wall	31 days	Mon 5/27/13
5	Zone 1	2 days	Thu 7/4/13
6	Zone 2	2 days	Tue 7/9/13
8	Zone 3	43 days	Wed 7/10/13
28	1st Floor Slab on Metal Deck	4 days	Tue 7/23/13
9	Zone 4	6 days	Wed 7/31/13
11	Zone 5	5 days	Tue 9/10/13
12	Zone 6	3 days	Tue 9/17/13
13	Zone7	6 days	Fri 9/20/13
7	Zone 2 Pavilion	1 day	Mon 9/23/13
29	2nd Floor Main Slab	5 days	Mon 9/23/13
10	Zone 4 Pavilion	1 day	Wed 9/25/13
14	Zone 7 Pavilion	5 days	Mon 9/30/13
15	Zone 8	5 days	Mon 10/7/13
16	Zone 9	5 days	Mon 10/14/13
17	Zone 10	3 days	Mon 10/21/13
18	MEP Rough-In Starts	0 days	Wed 10/23/13
19	Zone 11	6 days	Fri 11/8/13
20	Zone 12	37 days	Fri 11/8/13
21	Zone 13	3 days	Wed 11/13/13
22	Zone 14	34 days	Wed 11/13/13
23	Zone 15	51 days	Mon 11/18/13
24	Zone 16	41 days	Mon 11/18/13
31	3rd Floor West Slab	5 days	Mon 11/18/13
25	Zone 17	45 days	Mon 11/25/13
34	4th Floor West Slab	5 days	Mon 11/25/13
26	Zone 18	11 days	Mon 12/23/13
27	Zone 19	11 days	Mon 12/23/13
37	5th Floor Main Slab	5 days	Mon 2/3/14
38	5th Floor Pavilion Slab	5 days	Mon 2/3/14
39	Roof Slab	5 days	Mon 2/17/14
30	2nd Floor Pavilion Slab	5 days	Mon 2/24/14
35	4th Floor East Slab	5 days	Mon 2/24/14
36	4th Floor Pavilion Slab	5 days	Mon 2/24/14
32	3rdh Floor East Slab	5 days	Mon 3/3/14
33	3rd Floor Pavilion Slab	5 days	Mon 3/3/14
40	Superstructure Complete	0 days	Fri 3/7/14

Structural Sequencing Analysis

Zone Delays

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Structure Duration Comparisons



		Top-Down	Shoring
Description	Planned	Option	Option
Steel Erection Start	6/25/13	7/4/13	7/4/13
Structure Complete Milestone	1/1/14	3/7/14	2/13/14
Total Duration (weeks)	28	33	30

Sharing Cast Break Down

Shoring Cost Break Down					
Description	Per Tower	Total			
Minimum First 4 Weeks	\$1357	\$24,430			
Every Week After for 4 Weeks	\$828	\$14,900			
Tax (6%)	\$131	\$2,360			
Total	\$2,316	\$41,690			
Cost Comparisons					
Description	Per Tower				
General Condition Savings	\$72,000				
Shoring Costs	\$41,690				
Total Estimated Costs Savings	\$30,000				





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Mechanical Penthouse vs. IPEC Analysis



Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room **Acoustical Breadth** Summary of Conclusions Acknowledgments

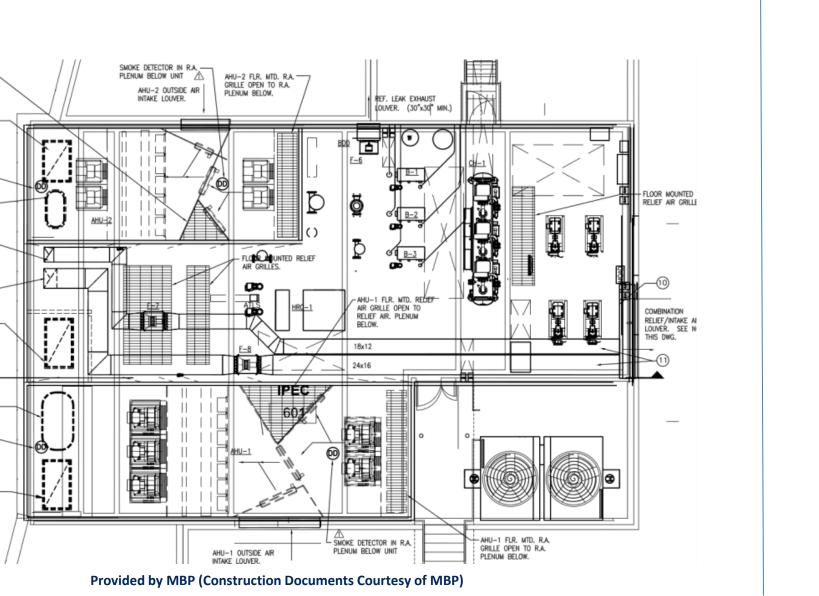
Goals

IPEC & Penthouse Differences How to Chose Which to Use Gain Knowledge of Each

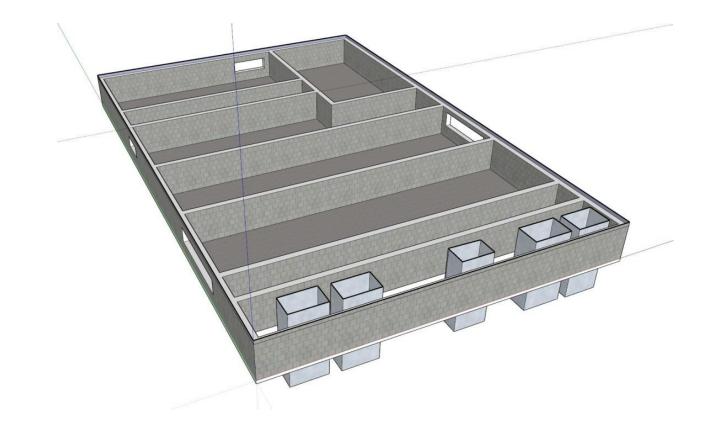
Mechanical Penthouse vs. IPEC Analysis

Outline Goals AHU-2 FLR. MTD. RELIEF AIR GRILLE OPEN TO RELIEF AIR. PLENUM BELOW, **Project Introduction IPEC & Penthouse Differences** 46x30 R.A. DUCT OPEN TO R.A. PLENUM BELOW UNIT. DUCT OPENING SHALL BE 6* ABOVE ARCHITECTURAL/STRUCTURAL How to Chose Which to Use Early Involvement Gain Knowledge of Each SMOKE DETECTOR IN UNIT --DISCHARGE AIR PLENUM Caisson Rebar Cage Prefab 42x20¢ CONNECTED TO -52x36 DISCHARGE PLENUM OPENING. IPEC Structural Sequencing 18x12 E.A. DUCT DOWN. SEE DWG M-105 FOR CONTINUATION Prefabricated Equipment Module Structural Breadth 24x16 E.A. DUCT DOWN. SEE DWG M-105 FOR CONTINUATION 4' CMU Base Wall 56x30 R.A. DUCT OPEN TO R.A. -PLENUM BELOW UNIT. DUCT OPENING SHALL BE 6* ABOVE ARCHITECTURAL/STRUCTURAL **One Supplier** Mechanical Room Acoustical Breadth 68x36¢ CONNECTED TO 108x36 DISCHARGE PLENUM OPENING. SMOKE DETECTOR IN UNIT DISCHARGE AIR PLENUM Summary of Conclusions 56x30 R.A. DUCT OPEN TO R.A. PLENUM BELOW UNIT. DUCT OPENING SHALL BE 6° ABOVE ARCHITECTURAL/STRUCTURAL FLOOR. Acknowledgments

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Integrated Packaged Equipment Center (IPEC)



Mechanical Penthouse vs. IPEC Analysis

Outline **Project Introduction** Early Involvement Caisson Rebar Cage Prefab Structural Sequencing Structural Breadth Mechanical Room Acoustical Breadth Summary of Conclusions Acknowledgments

Goals

IPEC & Penthouse Differences How to Chose Which to Use Gain Knowledge of Each

IPEC

Prefabricated Equipment Module 4' CMU Base Wall **One Supplier**

Mechanical Penthouse

Site Constructed On Concrete Structural Roof Multiple Different Suppliers



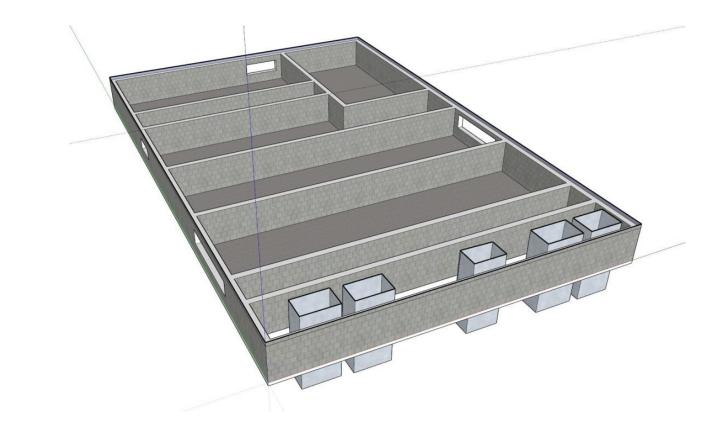
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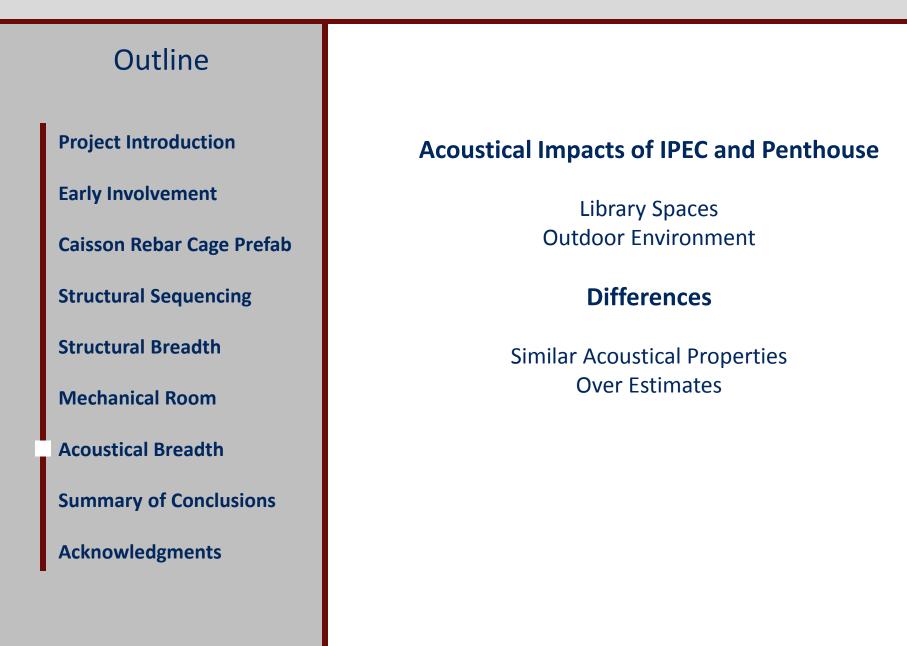
Mechanical Penthouse



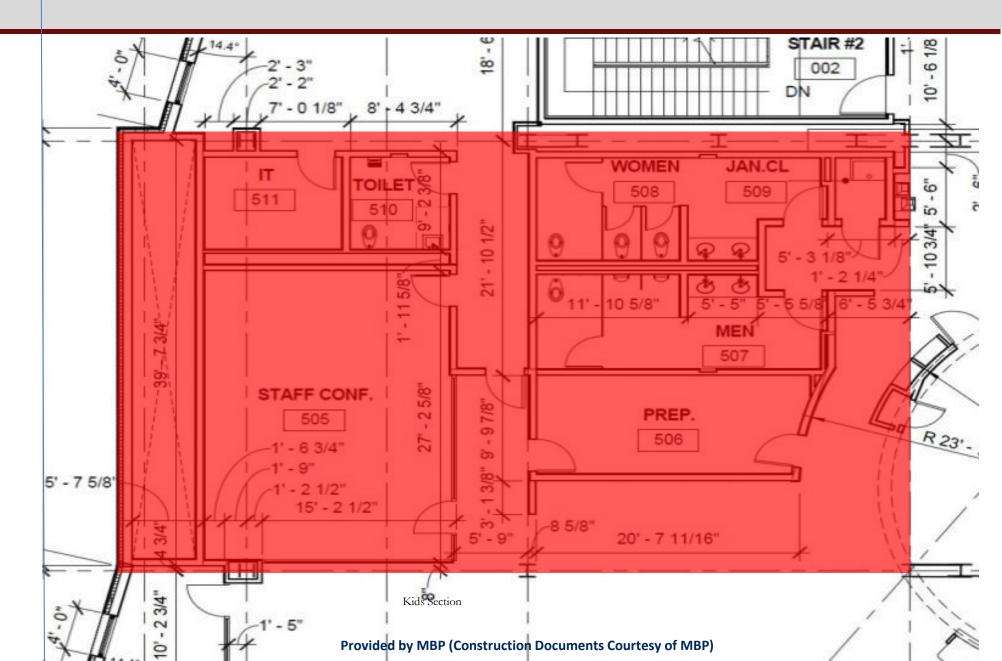
Picture Provided by http://www.jetsongreen.com/

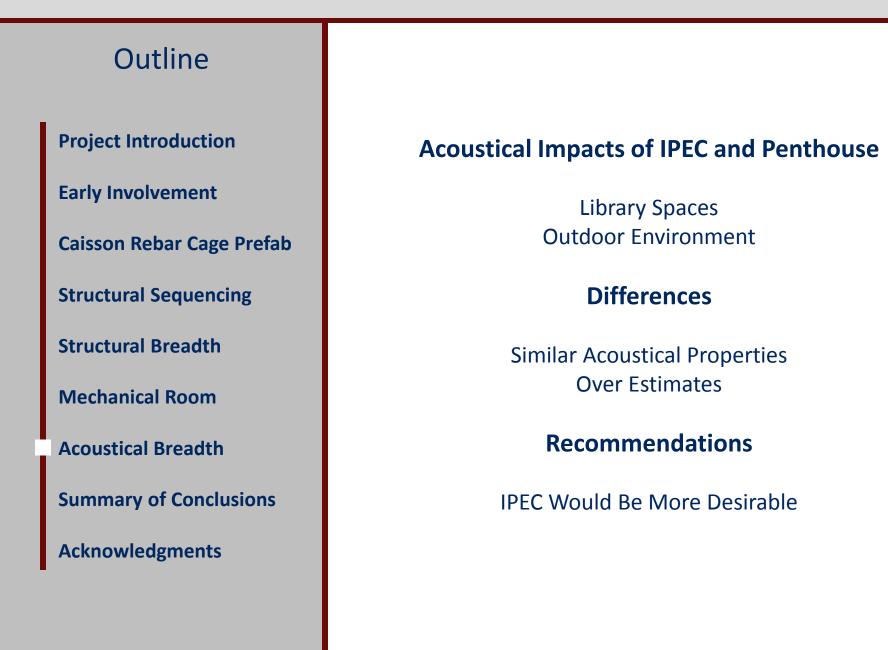
Integrated Packaged Equipment Center (IPEC)





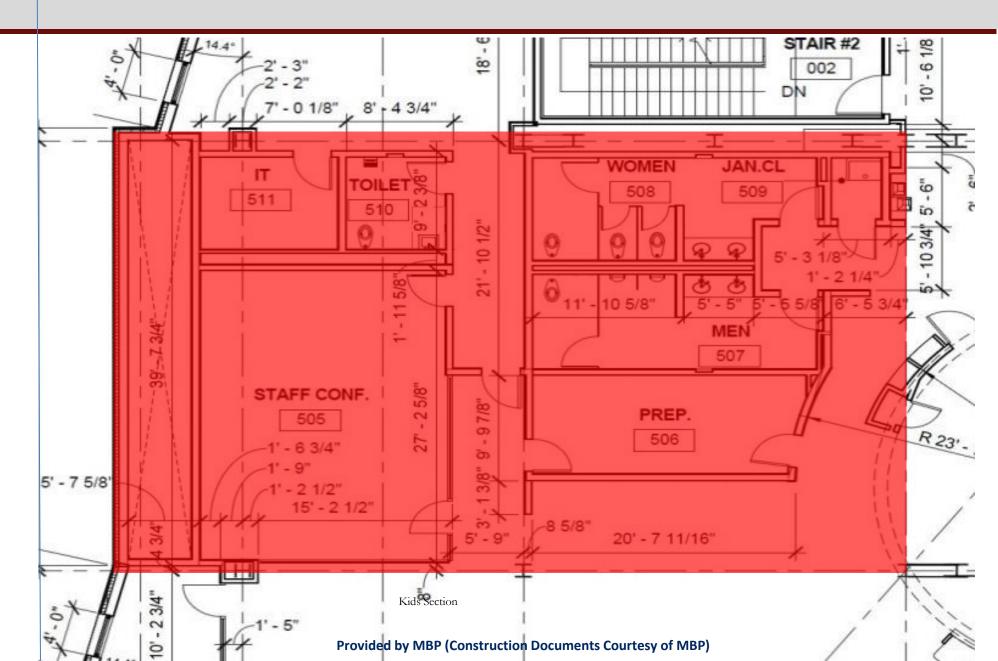
Acoustical Breadth





Conf Pro

Acoustical Breadth



Noise Levels								
	Limit	Actual						
erence Room	35 dB	37 dB						
operty Line	55 dB	57 dB						

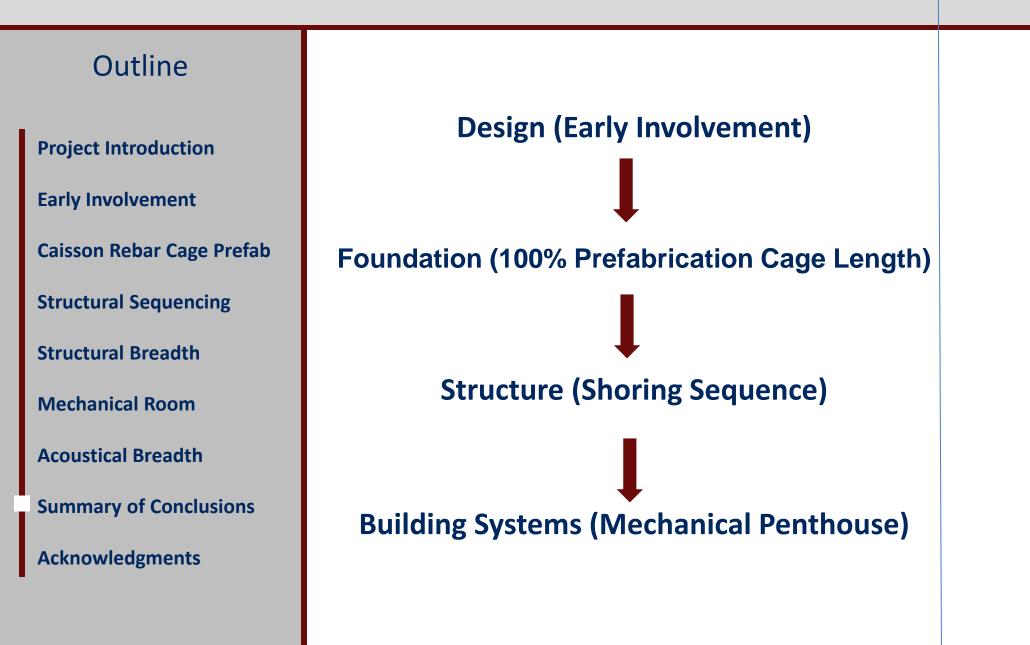




IPEC vs. Mechanical Penthouse Schedule								
System	Lead Time	Site Install Time						
IPEC	1 Long Lead Item (Months)	1 Week						
Penthouse	Multiple Shorter Lead Times (Weeks)	10.5 Weeks						

IPEC vs. Mechanical Penthouse Costs									
	Enclosure/								
System	Equipment	Structure	Total						
IPEC	\$5,800,000	\$50,000	\$5,850,000						
Penthouse	\$4,880,000	\$100,000	\$4,880,000						

IPEC vs. Mechanical Penthou	IPEC vs. Mechanical Penthouse							
Criteria & Categories	IPEC	Penthouse						
Acoustical	✓	\checkmark						
Maintenance	х	\checkmark						
Flexibility in Design	х	\checkmark						
Responsibility	✓	\checkmark						
Constructability	✓	\checkmark						
Costs	х	\checkmark						
Schedule	✓	х						



Conclusions

Early Involvement

Undetermined Cost Savings Undetermined Schedule Savings

100% Prefabrication Cage Length

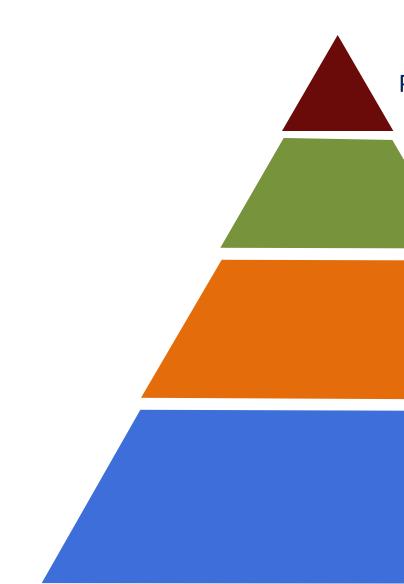
\$0.00 Savings Account for Caissons in Schedule

Shoring Sequence

\$30,000 Savings 3 Week Schedule Savings

Mechanical Penthouse

Possible \$1 Million Savings Additional 9.5 Week Mechanical Schedule



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Programming

Design

Procurement

Construction



Academic

Michelle Vigeant Moses Ling Dr. Robert Leicht Kevin Parfitt **Ray Sowers**

Special Thanks

Library's Owner PACE Industry Members Matt Strevig Friends and Family







Acknowledgments





McKinney Drilling Company



Engineering Your Vision







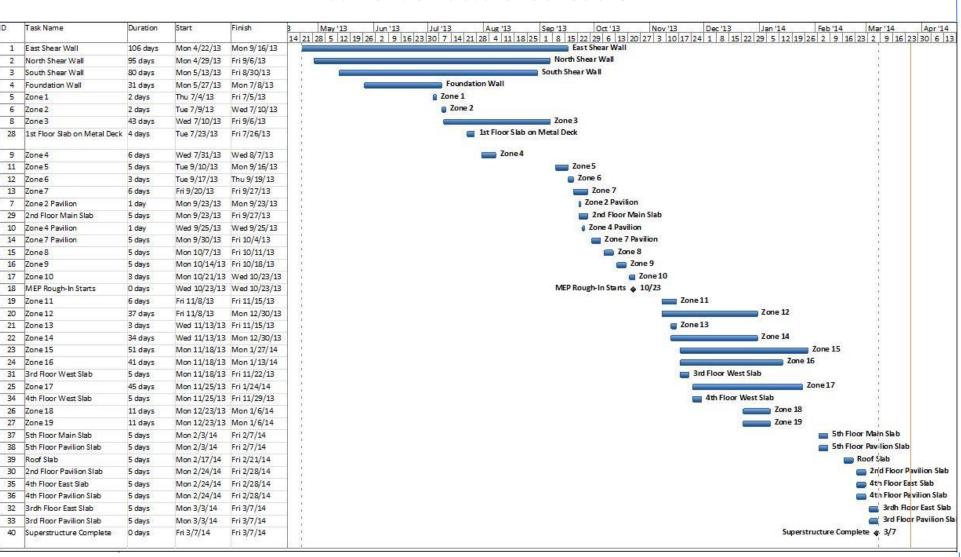




Questions?



Picture Provided by Multivista



Current Structural Schedule

Structural Analysis

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General Conditions Costs								
Description	Quantity	Unit	Per/Unit	Total				
Site Signage (Fence Cloth)	4,588	SF	\$36.04	\$165,351.52				
Perimater Fencing	1,185	LF	\$6.32	\$7,489.20				
Office Trailers (2)	22	Month	\$361.00	\$15,884.00				
Air Conditioning	22	Month	\$48.76	\$1,072.72				
125 Ton Crane	20	Month	\$16,000.00	\$320,000.00				
200 Ton (Crane Steel)			N/A					
1-1/2 CY Excavator	33	Month	\$8,700.00	\$287,100.00				
Backhoe 1-1/4 CY	22	Month	\$3,013.00	\$66,286.00				
500 BTU Heater	15	Month	\$425.00	\$6,375.00				
Portable Toilet	22	Month	\$191.78	\$4,219.16				
Permits	\$3,589,000.00	%	0.50%	\$17,945.00				
Field Office Bills	22	Month	\$377.00	\$8,294.00				
Main Office Expense	\$3,589,000.00	%	3.90%	\$139,971.00				
Builders Risk Insurance	\$3,589,000.00	%	0.42%	\$15,000.00				
Performance Bond	\$3,589,000.00	%	2.79%	\$100,000.00				
Liability Insurance	\$3,589,000.00	%	2.79%	\$100,000.00				
Multivista (Construction Documentations/ Webcam)	23	Month	\$1,700.00	\$39,100.00				
Project Executive	22	Week	\$2,475.00	\$54,450.00				
LEED Submittal Fees	22	Month	\$727.27	\$16,000.00				
CM Fees	\$3,589,000.00	%	3.00%	\$107,670.00				
Field Engineer	88	Week	\$1,325.00	\$116,600.00				
Project Manager	88	Week	\$2,150.00	\$189,200.00				
Superintendent	88	Week	\$2,000.00	\$176,000.00				
General Purpose Laborer	88	Week	\$1,425.00	\$125,400.00				
Schedule Maintainance	\$3,589,000.00	%	0.03%	\$1,076.70				
Temp. 600 Amp Elec.	1	EA	\$3,621.00	\$3,621.00				
Temp. 75kVA Transformer	1	EA	\$3,993.00	\$3,993.00				
Office Trailer Hook-Up	2	EA	\$374.00	\$748.00				
After Job Clean-up	\$3,589,000.00	%	0.30%	\$10,767.00				
Waste Removal Dumpster	88	Week	\$340.91	\$30,000.00				
Site Water	22	Month	\$70.00	\$1,540.00				
Commissioning	\$3,589,000.00	%	0.25%	\$8,972.50				
Total Project Planned Duration (We				\$2,140,125.80 88				
Total General Condition Costs	· · · · · · · · · · · · · · · · · · ·			\$24,319.61				
Total Scheral condition Costs	724,313.01							

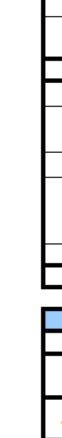
Shoring Sequence Schedule Task Name Duration Start Finish Apr'13 Jun'13 Jun'13 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 1 8 15 22 Mon 4/1/13 Fri 2/14/14 319 days Shoring Sequence 19 days Mon 4/1/13 Fri 4/19/13 Excavation Excavation East Shear Wall 148 days Mon 4/22/13 Mon 9/16/13 131 days Mon 4/29/13 Fri 9/6/13 North Shear Wall 110 days Mon 5/13/13 Fri 8/30/13 South Shear Wall Foundation Wall 43 days Mon 5/27/13 Mon 7/8/13 Foundation Wa 1st Floor North Beams 2 days Thu 7/4/13 Fri 7/5/13 🍙 1st Floor North Bear North Columns 2 days Thu 7/4/13 Fri 7/5/13 North Columns 1st Floor South 1st Floor South Beams 2 days Tue 7/9/13 Wed 7/10/13 Tue 7/9/13 Wed 7/10/13 South Columns South Columns 2 days 2nd Floor North Beams 59 days Wed 7/10/13 Fri 9/6/13 -----2nd Floor South Beams 8 days Wed 7/31/13 Wed 8/7/1 3rd Floor Main Beams Tue 9/10/13 Sat 9/21/1 12 days 4th Floor Main Beams 13 days Tue 9/24/13 Sun 10/6/1 5th Floor Main Beams 8 days Tue 10/8/13 Tue 10/15/13 Boof Main Beams 5 days Wed 10/16/13 Sun 10/20/13 East Side of Trusses 5 days Wed 10/16/13 Sun 10/20/13 1st Floor Slab 4 days Tue 10/22/13 Fri 10/25/13 Scaffolding Foundations 85 days Tue 10/22/13 Tue 1/14/14 2nd Floor Main Slab 12 days Mon 10/28/13 Fri 11/8/13 Scaffolding Framing 61 days Sat 11/9/13 Wed 1/8/14 3rd Floor West Slab 19 days Mon 11/11/13 Fri 11/29/13 MEP Rough in Starts 0 days Thu 11/14/13 Thu 11/14/13 Hanging Columns 3 days Tue 11/19/13 Thu 11/21/13 3rd Floor Hanging Zone 1 5 days Fri 11/22/13 Tue 11/26/13 4th Floor Hanging Zone 1 4 days Wed 11/27/13 Sat 11/30/13 4th Floor West Slab 19 days Mon 12/2/13 Fri 12/20/13 5 5th Floor Hanging Zone 1 2 days Tue 12/3/13 Wed 12/4/13 5 Roof Hanging Zone 1 4 days Thu 12/5/13 Sun 12/8/13 7 3rd Floor Hanging Zone 2 3 days Mon 12/9/13 Wed 12/11/13 8 4th Floor Hanging Zone 2 4 days Wed 12/11/13 Sat 12/14/13 9 5th Floor Hanging Zone 2 3 days Mon 12/16/13 Wed 12/18/13 32 West Side of Trusses 5 days Thu 12/19/13 Mon 12/23/13 30 Roof Hanging Zone 2 9 days Thu 12/26/13 Fri 1/3/14 39 Pavilion Columns 3 days Mon 1/6/14 Wed 1/8/14 37 5th Floor Slab 6 days Fri 1/10/14 Wed 1/15/14 40 2nd Floor Pavilion Beams 3 days Mon 1/13/14 Wed 1/15/14 3rd Floor Pavilion 3 days Mon 1/13/14 Wed 1/15/14 B Roof Slab 5 days Thu 1/16/14 Mon 1/20/14 2 4th Floor Pavilion 3 days Thu 1/16/14 Sat 1/18/14 13 5th Floor Pavilion 3 days Mon 1/20/14 Wed 1/22/14 36 4th Floor East Slab 4 days Tue 1/21/14 Fri 1/24/14 34 3rdh Floor East Slab 3 days Mon 1/27/14 Wed 1/29/14 44 2nd Floor Pavilion Slab 3 days Thu 1/30/14 Sat 2/1/14 15 3rd Floor Pavilion Slab 3 days Mon 2/3/14 Wed 2/5/14 6 4th Floor Pavilion Slab 3 days Thu 2/6/14 Sat 2/8/14 Roof Pavilion Slab 4 days Mon 2/10/14 Thu 2/13/14 48 Superstructure Complete O days Fri 2/14/14 Fri 2/14/14

Aug'13 Sep '13 Oct '13 Nov '13 Dec '13 Jan '14 Feb '14	Mar '14
9 5 12 19 26 2 9 16 23 30 7 14 21 28 4 11 18 25 2 9 16 23 30 6 13 20 27 3 10	17 24 3 10 17
Cont Character	
East Shear Wall	
North Shear Wall	
South Shear Wall	
22	
eams	
2nd Floor North Beams	
2nd Floor South Beams	
3rd Floor Main Beams	
4th Floor Main Beams	
5th Floor Main Beams	
Roof Main Beams	
East Side of Trusses	
1st Floor Slab	
Scaffolding Foundations	
2nd Floor Main Slab	
Scaffolding Framing	
and the second sec	
MEP Rough In Starts 🖕 11/14	
💼 Hanging Columns	
i 3rd Floor Hanging Zone 1	
🚃 4th Floor Hanging Zone 1	
4th Floor West Slab	
5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	
🚃 Roof Hanging Zone 1	
🚃 3rd Floor Hanging Zone 2	
🚃 4th Floor Hanging Zone 2	
Sth Floor Hanging Zone 2	
West Side of Trusses	
Roof Hanging Zone 2	
Pavilion Columns	
5th Floor Slab	
💼 2nd Floor Pavilion Beam	5
y 3rd Floor Pavilion	
Roof Slab	
4th Floor Pavilion	
i Sth Floor Pavilion	
🚃 4th Floor East Si	
and Floor E	
and Floor and Fl	Pavilion Slab
🔤 3rd Flø	or Pavilion Slab
= 4th	Floor Pavilion Slab
	Roof Pavilion Slab
Superstructure Complete 🧉	2/14

Dead Load Calculations

Dead Load Calculations								
Description	Sizes	lb/LF	Spacing (ft)	lb/SF				
Columns	W14x82	82	40x50	2				
Trusses	W14x283	283	40	7				
	W14x90	90	40	2				
	W14x99	99	40	2				
End Truss	W14x233	233	50	5				
	W14x90	90	50	2				
3rd Floor Girder	W36x135	135	40	3				
	W24x55	55	40	1				
3rd Floor Beams	W27x84	84	10	8				
4th Floor Girder	W27x84	84	40	2				
	1121701		10	2				
4th Floor Beams	W21x50	50	10	5				
5th Floor Beams	W27x84	84	10	8				
Roof Floor Beams	W21x44	44	5	9				
Decking				5				
Allowance				8				
Total Dead Load (Ib/SF)								





Live Load & Factored Loads

Live Load Calculations											
	Live Load of Construction										
		Surface	50								
		# of Floors	4								
Live Loa	200										
		K _{LL}	4								
	Tributary Area=										
	A _T	20x18	360								
		SQRT (K _{LL} *A _T)	37.95								
		0.25+{15/ SQRT									
		(K _{LL} *A _T)}	0.65								
		Not smaller than	0.4 so use 0.65								
Live Loa	ad Reduced (Ib/	SF)= L	129								

Total Load Calculations	
Total Load= 1.2D+1.6L (Ib/SF)= P _U	291
Shoring Tower Estimated Spacing	20x18
Total Estimated Load per Shoring Tower (kip)	105

Live Load Assumptions

- Started with 50 psf
- Four floors is 200 psf
- In live load reduction total is 129 psf
- Factored live load would then be 206 psf (This would be an acceptable live load on four floors of **only structure**)





Absorption Under IPEC Zone 2													
Surfaco	Area (Sq.		Abs	orption C	oefficient	ts							
Surface ft.)	ft.)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Concrete	128	0	0	0	0	0	0	1	1	3	3	3	3
Ridged Insulation (3in.)	346	0	1	1	1	1	1	131	207	270	276	270	242
Metal IPEC Bottom	128	0	0	0	0	0	0	19	24	28	50	49	38
	Total Absorption (sabins): $a=\Sigma S\alpha \rightarrow$						151.81	232.96	300.29	328.96	320.77	282.88	

Zone 2 Acoustics

Transmission Losses (dB)									
				<u> </u>					
band Center Frequencies		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC Rating	
f IPEC		37.0	45.0	54.0	60.0	65.0	47.0	62.0	

Est	imated No	osie Level in	Zone 2							
ve-band Center Frequencies	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz				
etween IPEC and Under IPEC Zone 2	37	45	54	60	65	47				
a ₂	152	233	300	329	321	283				
face Area Between Spaces (sq. ft.)	160									
oise Reduction of Noise Coming from IPEC	37	47	57	63	68	49				
Sound Pressure in IPEC	86	85	84	83	82	80				
d Pressure in Zone 2 From IPEC Space	49	38	27	20	14	31				

Transmission Losses (dB)											
Octave-band Center Frequencies		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	STC Rating			
8" reinforced concrete slab		44.0	48.0	55.0	58.0	63.0	67.0	58.0			

	rence Spa	ice											
Surface	Area (Sq.		Abs	orption C	oefficient	:S							
Surrace	ft.)	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Carpet on Foam	409	0	0	1	1	1	1	33	98	233	282	291	299
Gypsum Board, 5/8''	506	1	0	0	0	0	0	279	71	41	20	61	56
Acoustical Ceiling, 3/4"													
	409	1	1	1	1	1	1	311	381	340	405	405	385
Chairs, Occupied	32	0	0	0	1	1	1	10	13	16	27	28	27
Total Absorption (sabins): $a=\sum S\alpha \rightarrow$								632	562	629	735	784	766

Between Zone1 and Staff Conference Space											
Surface Area Between Spaces											
(sq. ft.)	325										
Noise Reduction of Noise											
Coming from Zone 1	42	48	56	60	65	68					
Sound Pressure in Zone 1	86	85	84	83	82	80					
Sound Pressure in Staff											
Conference Space from Zone 1	44	37	28	23	17	12					

Acoustical Breadth Calculations

Lowell Stine | Construction

Conference Room Acoustics

Between Zone 2 and Staff Conference Space												
Surface Area Between Spaces												
(sq. ft.)	120											
Noise Reduction of Noise												
Coming from Zone 2	47	52	60	64	69	72						
Sound Pressure in Zone 2	49	38	27	20	14	31						
Sound Pressure in Staff												
Conference Space from Zone 2	3	-14	-33	-44	-55	-42						

Between Zone 3 and Staff Conference Space

Surface Area Between Spaces						
(sq. ft.)	293					
Noise Reduction of Noise						
Coming from Zone 3	43	48	57	60	65	69
Sound Pressure in Zone 3	86	85	84	83	82	80
Sound Pressure in Staff						
Conference Space from Zone 3	43	37	27	23	17	11

Between Zone 4 and Staff Conference Space

Surface Area Between Spaces						
(sq. ft.)	144					
Noise Reduction of Noise						
Coming from Zone 4	46	52	60	63	68	72
Sound Pressure in Zone 4	86	85	84	83	82	80
Sound Pressure in Staff						
Conference Space from Zone 4	40	33	24	20	14	8

Estimated Sound Pressure Level in Staff Conference Space												
Octave-band Center Frequencies	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
From Zone 1	44	37	28	23	17	12						
From Zone 2	3	-14	-33	-44	-55	-42						
From Zone 3	43	37	27	23	17	11						
From Zone 4	40	33	24	20	14	8						
Add From Zone 1 and 2 Combined	0	0	0	0	0	0						
From Zone 1 and 2 Combined	44	37	28	23	17	12						
Add From Zones 3 and 4 Combined	2	2 1 2	2	2	1							
From Zones 3 and 4 Combined	45	38	29	25	19	12						
Add From Zone (1 and 2) and (3 and 4) Combined	3	3	3	2	2	3						
Estimated Sound Level in Staff Conference Space from IPEC	48	41	32	27	21	15						
A-Weighting	-15	-8	-3	0	1	1						
A-Weighted Noise from IPEC	33	33	29	27	22	16						
dB Addition Add		3	2		-	L						
Result	3	6	3:	1	2	3						
dB Addition Add		1			0							
Result		23										
dB Addition Add			0									
Sound Level			37 d	B								

Equipment

Quantity	Assembly Number	Description	Unit	Material O&P	Installation		Total O&P	E	xt. Material O&P	Ext. Installation	Ext. Total
4	D30201061080	Boiler, gas, cast iron, hot water, 1,088 MBH	Ea.	\$ 14,914.90	\$ 4,706.35	\$	19,621.25	\$	59,659.60	\$ 18,825.40	\$ 78,485.00
90000	D30301154040	Packaged chiller, water cooled, with fan coil unit, offices, 60,000 SF, 190.00 ton	S.F.	\$ 7.76	\$ 5.19	s	12.95	\$	698,400.00	\$ 467,100.00	\$ 1,165,500.00
40000	D30201081280	Heating systems, CI boiler, gas, terminal unit heaters, 80 MBH, 1,070 SF bldg	S.F.	\$ 10.76	\$ 7.56	\$	18.32	\$	430,400.00	\$ 302,400.00	\$ 732,800.00
90000	D30501703680	Split system, air cooled condensing unit, offices, 20,000 SF, 63.32 ton	S.F.	\$ 5.46	\$ 4.64	\$	10.10	\$	491,400.00	\$ 417,600.00	\$ 909,000.00
5	D30203301030	Pump, base mounted with motor, end- suction, 4" size, 7-1/2 HP, to 350 GPM	Ea.	\$ 15,015.00	\$ 4,107.50	\$	19,122.50	\$	75,075.00	\$ 20,537.50	\$ 95,612.50
2	D30203301020	Pump, base mounted with motor, end- suction, 3" size, 5 HP, to 225 GPM	Ea.	\$ 12,812.80	\$ 3,426.30	\$	16,239.10	\$	25,625.60	\$ 6,852.60	\$ 32,478.20
2	D30203301040	Pump, base mounted with motor, end- suction, 5" size, 15 HP, to 1000 GPM	Ea.	\$ 20,720.70	\$ 6,050.15	\$	26,770.85	\$	41,441.40	\$ 12,100.30	\$ 53,541.70
11	D30203301010	Pump, base mounted with motor, end- suction, 2-1/2" size, 3 HP, to 150 GPM	Ea.	\$ 11,711.70	\$ 2,994.10	\$	14,705.80	\$	128,828.70	\$ 32,935.10	\$ 161,763.80
90000	D30301103400	Packaged chiller, air cooled, with fan coi unit, offices, 6,000 SF, 19.00 ton	S.F.	\$ 9.71	\$ 5.68	\$	15.39	\$	873,900.00	\$ 511,200.00	\$ 1,385,100.00
1	D30406101010	Plate heat exchanger, 400 GPM	Ea.	\$ 53,553.50	\$11,745.60	\$	65,299.10	\$	53,553.50	\$ 11,745.60	\$ 65,299.10
2	D30402401040	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 2750 CFM	Ea.	\$ 3,578.58	\$11,446.60	\$	15,025.18	\$	7,157.16	\$ 22,893.20	\$ 30,050.36
1	D30402401030	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 1500 CFM	Ea.	\$ 2,402.40	\$ 5,061.10	\$	7,463.50	\$	2,402.40	\$ 5,061.10	\$ 7,463.50
1.33	D30401161050	AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM	Ea.	\$173,173.00	\$17,149.20	\$	190,322.20	\$	230,320.09	\$ 22,808.44	\$ 253,128.53
1.1	D30401161030	AHU, rooftop, cool/heat coils, VAV, filters, 15,000 CFM	Ea.	\$116,616.50	\$12,413.80	\$			128,278.15		\$ 141,933.33
							Subtotals	\$:	3,246,441.60		\$5,112,156.02
							ocation Scale			91%	\$4,652,061.98
							COH & Profit			5%	\$232,603.10
						6	Grand Total				\$4,884,665.08

Penthouse Costs

Enclosure

Quantity	Assembly Number	Description	Unit	aterial D&P	Inst	allation	Т	otal O&P	E)	t. Material O&P	Ext	t. Installation	Ext. Total
		Floor is Same Stuctural Concrete					\$	-	\$	-	\$	-	\$-
3000	B10201206400	Steel Joist Roof	S.F.	\$ 5.05	\$	2.96	\$	8.01	\$	15,150.00	\$	8,880.00	\$ 24,030.00
3000	B30101206500	Single Ply 60 mils, PVC Membrane Roof Coverings Adhered	S.F.	\$ 1.41	\$	0.92	\$	2.33	\$	4,230.00	\$	2,760.00	\$ 6,990.00
3750	B2010146	Corrugated 22 Ga.Galvanized Steel with Structural Steel Support, Colored	S.F.	\$ 4.19	\$	3.60	\$	7.79	\$	15,712.50	\$	13,500.00	\$ 29,212.50
3000	D50202360960	Low Bay Lighting Fixtures, 250 watt Metal Halide	S.F.	\$ 4.23	\$	5.55	\$	9.78	\$	12,690.00	\$	16,650.00	\$ 29,340.00
		Allowance					\$	-	\$	-	\$	-	\$ 12,000.00
		-	-		-		9	Subtotals	\$	47,782.50	\$	41,790.00	\$101,572.50
							Loc	ation Scale				91%	\$92,532.55
							Inf	lation of 3 Years				3%	\$95,308.52
							GC	OH & Profit				5%	\$4,765.43
							Gr	and Total					\$100,073.95

Equipment

Quantity	Assembly Number	Description	Unit	Productivity (units/day)	Crews	Duration (days)
4	D30201061080	Boiler, gas, cast iron, hot water, 1,088 MBH	Ea.	0.3	3	4.4
2	D30301154040	Packaged chiller, water cooled, with fan coil unit, offices, 60,000 SF, 190.00 ton	Ea.	0.1	3	6.7
2	D30501703680	Split system, air cooled condensing unit, offices, 20,000 SF, 63.32 ton	Ea.	0.4	1	5.0
5	D30203301030	Pump, base mounted with motor, end- suction, 4" size, 7-1/2 HP, to 350 GPM	Ea.	5	1	1.0
2	D30203301020	Pump, base mounted with motor, end- suction, 3" size, 5 HP, to 225 GPM	Ea.	7	1	0.3
2	D30203301040	Pump, base mounted with motor, end- suction, 5" size, 15 HP, to 1000 GPM	Ea.	3	1	0.7
11	D30203301010	Pump, base mounted with motor, end- suction, 2-1/2" size, 3 HP, to 150 GPM	Ea.	7	1	1.6
2	D30301103400	Packaged chiller, air cooled, with fan coil unit, offices, 6,000 SF, 19.00 ton	Ea.	0.3	1	6.7
1	D30406101010	Plate heat exchanger, 400 GPM	Ea.	0.8	1	1.3
2	D30402401040	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 2750 CFM	Ea.	2	1	1.0
1	D30402401030	Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 1500 CFM	Ea.	2	1	0.5
1.33	D30401161050	AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM		0.3	1	4.4
1.1	D30401161030	AHU, rooftop, cool/heat coils, VAV, filters, 15,000 CFM	Ea.	0.3	1	3.7
					Total Days	37

Penthouse Durations

Enclosure

Quantity	Assembly Number	Description	Unit	Productivity (units/day)	Crews	Duration (days)
		Floor is Same Structural Concrete				
2400	B10201206400	Steel Joist Roof	L.F.	160	2	7.5
2400	B30101206500	Single Ply 60 mils, PVC Membrane Roof Coverings Adhered	S.F.	250	2	4.8
2400	B2010146	Corrugated 22 Ga.Galvanized Steel with Structural Steel Support, Colored	L.F.	800	1	3
					Total Days	15.3