CANNONDESIGN

ECMC Skilled Nursing Facility 462 Grider Street Buffalo, NY 14215

ECMC Skilled Nursing Facility

Brian Brunnet Structural Option AE 482 – Senior Thesis Dr. Ali Memari





Presentation Outline

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments







Building Statistics:

Project Background

• Location: 462 Grider St. Buffalo, NY 14215 Occupant: Erie County Medical Center Occupancy Type: Medical • Size: 296,000 SF • Number of Stories: 6 Maximum Height: 90'-0" Completion Date: July 2012 Project Cost: \$95 Million Delivery Method: Design-Bid-Build



Project Team:

- Owner: ECMC Corporation
- Architect: Cannon Design
- Construction Manager: LP Ciminelli
- Structural Engineer: Cannon Design
- Civil Engineer: Watts Architecture & Engineering
- MEP Engineer: M/E Engineering

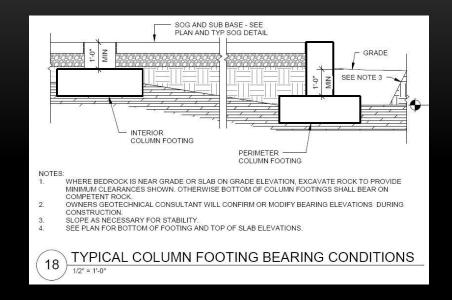




1.	Project Background	Existir
2.	Scope of Work	Foundation S
3.	Structural Depth Study	 5" Slab c
	i. Foundation System	• 12" Cond
	ii. Gravity System	Square S
	iii. Lateral Force Resisting System	• Siz
4.	Mechanical Breadth	• De • 30
5.	Construction Management Breadth	• Sc
6.	Summary of Conclusions	
7.	Acknowledgments	

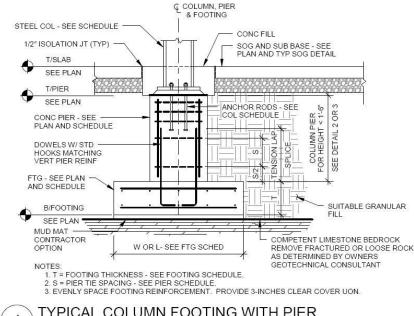
Project Background

- sting Structural System
- n System:
- ab on Grade
- oncrete Mat beneath elevator core
- re Spread Footings
- Sizes range from 3'-6" to 7'
- Depths range from 1'-8" to 2'-8"
- 3000 psi Normal Weight concrete
- Soil Bearing Capacity of 16,000 psf



FO	0	TII	NC	3

ALLOWABLE BEARING PRESSURE : 16000 PSF								
MARK WIDTH LENGTH DEPTH (EW BOT UON) REMARKS								
F3.5	3'-6"	3'-6"	1'-8"	5-#5				
F4.5	4'-6"	4'-6"	1'-10"	8-#5				
F4.5-6.5	4'-6"	6'-6"	1'-10"	8-#5 LW, 10-#7 SW				
F5.5	5'-6"	5'-6"	2'-2"	6-#7				
F6.5	6'-6"	6'-6"	2'-6"	9-#7				
F6.5-8	6'-6"	8'-0"	2'-6"	9-#7 LW, 12-#7SW				
F7-A3	7'-0"	7'-0"	2'-8"	10-#7 B, 12-#7 T	HOOK TOP BARS, SEE DETAILS 15 & 16			
F7-A4	7'-0"	7'-0''	2'-8"	10-#7 B, 12-#7 T	HOOK TOP BARS, SEE DETAILS 15 & 16			



TYPICAL COLUMN FOOTING WITH PIER

SCHEDULE

	Projec
1. Project Background	Existin
2. Scope of Work	Gravity Syster
 Structural Depth Study 	Composi
i. Foundation System	• 5 ¹ /4
ii. Gravity System	De
iii. Lateral Force Resisting System	• Ble
4. Mechanical Breadth	
5. Construction Management Breadth	 Composi Co
Summary of Conclusions	• Bea
7. Acknowledgments	• Gir
	• Co

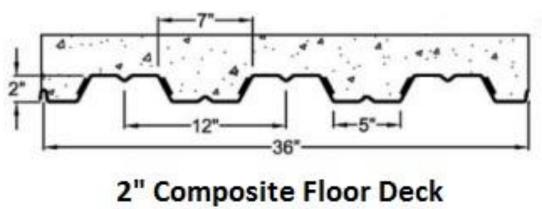
ct Background

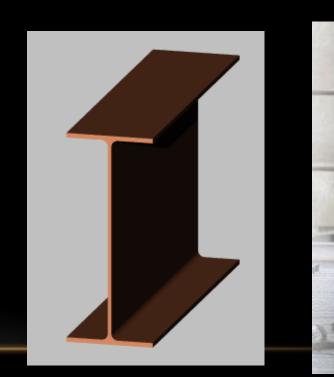
ng Structural System

- ite Metal Decking
- " LWC Floor Slab on 2" 20 Gage Metal
- cking
- ended Fiber Reinforcement

ite Steel Framing

- olumn Sizes of W10
- eam Sizes of W12 to W16
- rder sizes ranged from W14 to W24
- olumn Splices at 2nd and 4th floors







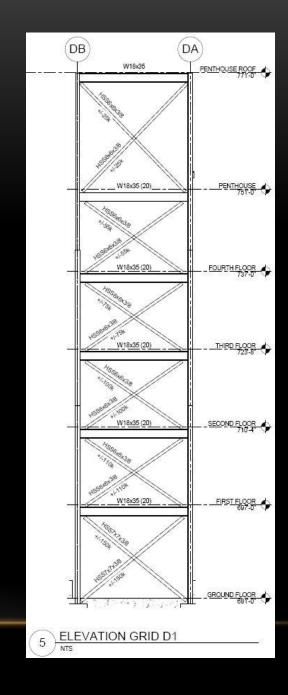
- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - Foundation System
 - Gravity System İİ.
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

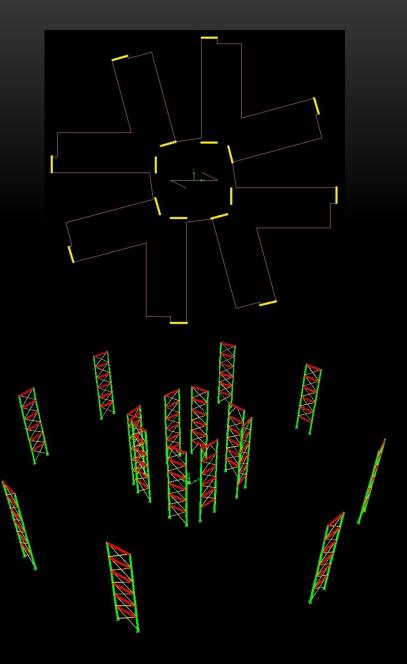


 \bullet

Project Background

- Existing Structural System
- Lateral Force Resisting System:
 - Concentrically Braced Frame system
 - HSS Cross Bracing range in size from 6x6x3/8 to
 - 7x7x1/2
 - Lateral system located at the end of each and surrounding the building core
 - Layout consists of a Radial Geometry







Problem Statement:

- Existing Structural System currently the most efficient \bullet and economical
- Design Similar Structural System for Downtown Los Angeles, CA
- \bullet

Problem Solution:

- Design Adequate Foundations
- Design Lighter Floor System
- Design Sufficient Lateral System:

 - •

Buffalo, NY

Scope of Work

High Seismic activity in this new location

- Base Isolation
- Concentric Braced Frame System



Los Angeles, CA

1.	Project Background	Project Goa
2.	Scope of Work	Structu
3.	Structural Depth Study	•
	i. Foundation System	•
	ii. Gravity System	•
	iii. Lateral Force Resisting System	
4.	Mechanical Breadth	Mechai
5.	Construction Management Breadth	•
6.	Summary of Conclusions	
7.	Acknowledgments	Constru

Scope of Work

als:

- ural Depth Study
- Reduce Floor System Weight
- Maintain Architectural Layout
- Design Adequate Foundation and Lateral
- Systems for new location
- anical Breadth Study
- Verify Existing mechanical AHU's are adequate
- for new location's climate
- Impact on construction schedule & cost



Buffalo, NY:

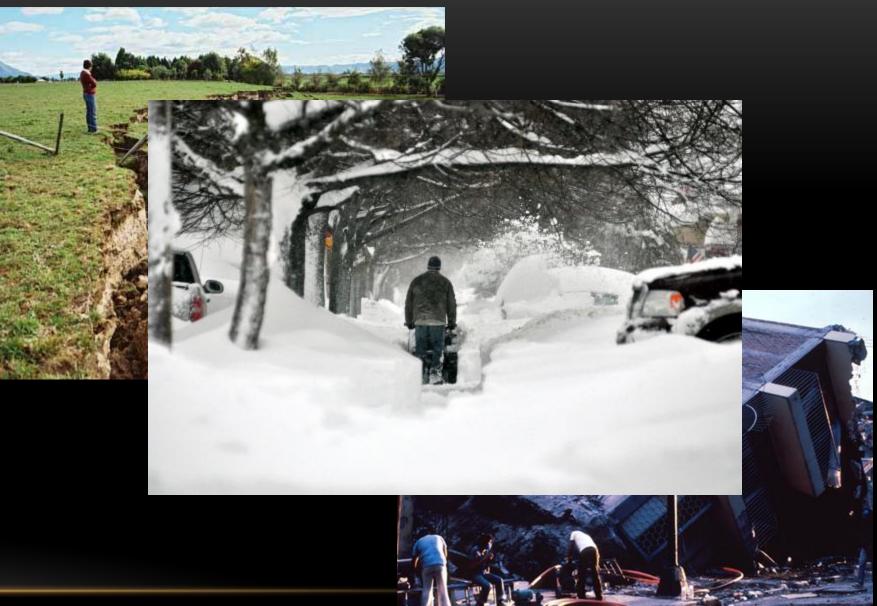
Los Angeles, CA:

- Highly Active Seismic Region
- Possibility of Soil Liquefaction
- Bedrock is located around 80' depth
- Densely Populated Area

- 1. Project Background 2. Scope of Work 3. Structural Depth Study i. Foundation System ii. Gravity System iii. Lateral Force Resisting System 4. Mechanical Breadth 5. Construction Management Breadth 6. Summary of Conclusions
- 7. Acknowledgments

Structural Depth Study

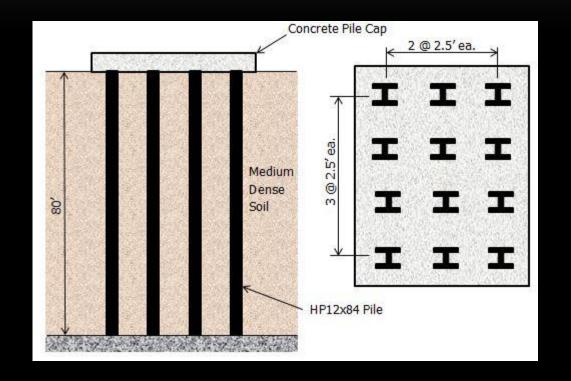
- Wind Loads primarily dominated Lateral System Design Snow Loads contributed to Gravity System
- Frequent Earthquakes





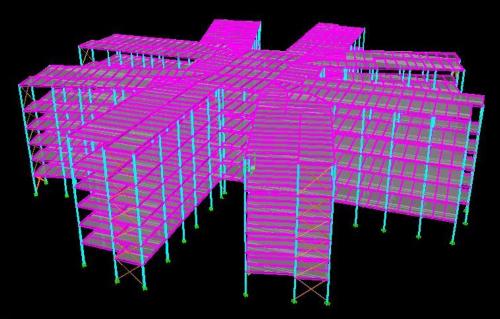


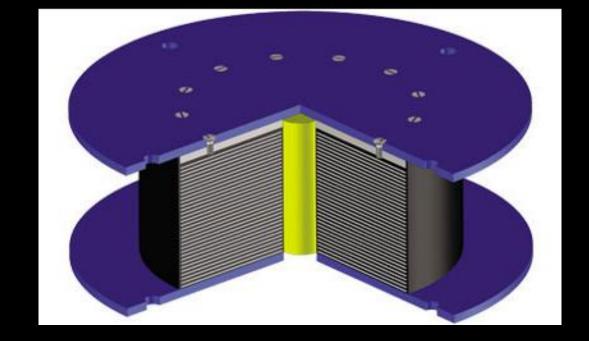
The following systems will be evaluated:



Foundation System

Structural Depth Study





Gravity System

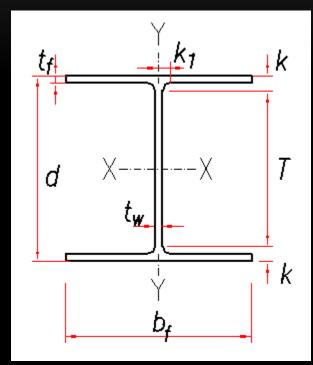
Lateral Force Resisting System



1.	Project Background	Los Angeles
2.	Scope of Work	• 2,000 t
3.	Structural Depth Study	• Large
	i. Foundation System	• 80' dep
	ii. Gravity System	 Possib
	iii. Lateral Force Resisting System	
4.	Mechanical Breadth	Solution: D
5.	Construction Management Breadth	Driven
6.	Summary of Conclusions	• Use of • F
7.	Acknowledgments	

Foundation System

- s, CA:
- to 5,000 psi bearing strength Vertical/Lateral Loads on foundation pth to Limestone Bedrock bility of Liquefaction
- Deep Foundation
- piles provide adequate bearing strength Bodine Resonant Pile Driver Relatively Quiet Vs. Impact Hammer





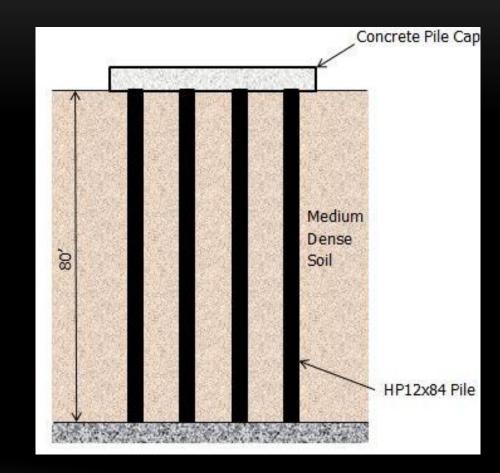


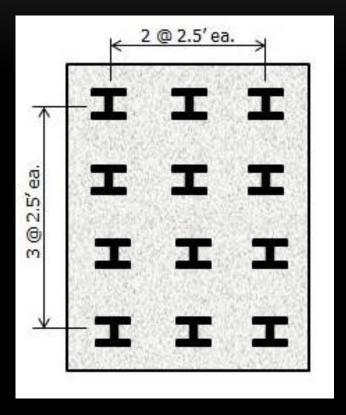
- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

- Deep Foundation Design Results: Pile Shape Size: HP12x84 • Pile Capacity: 597 Kips / Pile • Safety Factor: 3.5 • Pile Length: 80' (bearing on bedrock)

 - Largest Footing: 9' x 6' w/ 12 Piles

Foundation System



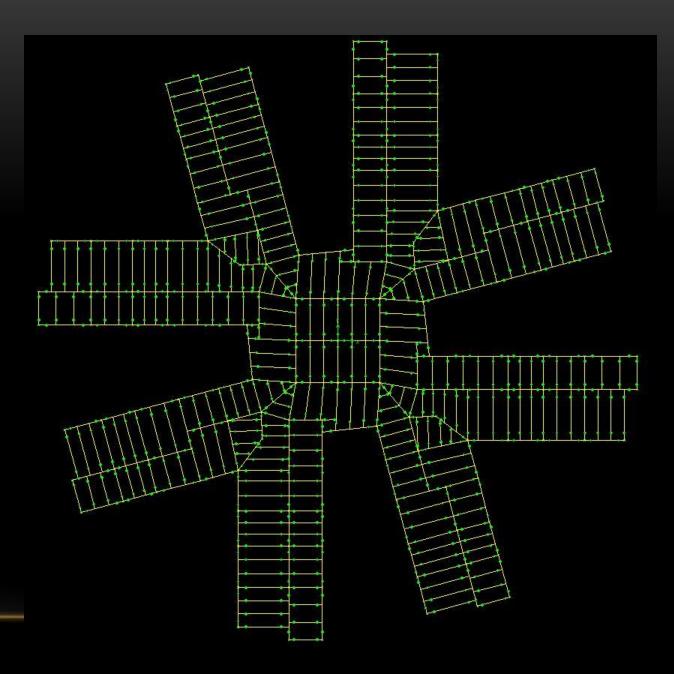


- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Framing Plan:

- Bays vary in size / largest = 29'-2" x 26'-0" Columns match wall partitions in plan Composite Decking spans parallel to wing \bullet Beams span perpendicular to wing \bullet Girders span parallel to wing \bullet



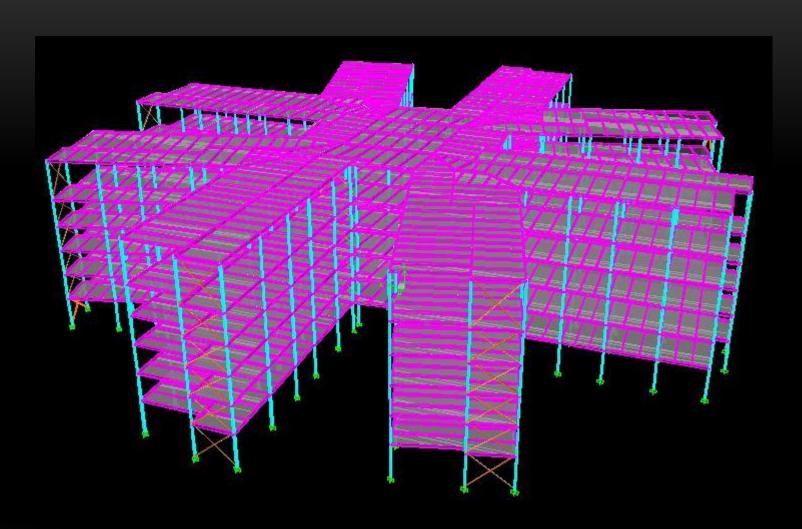


1.	Project Background
2.	Scope of Work
3.	Structural Depth Study
	i. Foundation System
	ii. Gravity System
	iii. Lateral Force Resisting System
4.	Mechanical Breadth
5.	Construction Management Breadth
6.	Summary of Conclusions
7.	Acknowledgments



Design Loads:

- ASCE 7-10
 - Live loads
 - Superimposed Dead Loads
- Serviceability Criteria: Deflection
 - Live Load = L/360
 - Total Load = L/240
- **Controlling Load Combination:**
 - 1.2D + 1.6L + 0.5L_r



1.	Project Background	Gravity Syste
2.	Scope of Work	Composition
3.	Structural Depth Study	• 3
	i. Foundation System	• 5
	ii. Gravity System	• R
4.	iii. Lateral Force Resisting System Mechanical Breadth	 Compositive W
5.	Construction Management Breadth	• R
	Summary of Conclusions Acknowledgments	Compos
	- A control and a control and a control and a control and a control and a control and a control and a control a	• V • S

Gravity System

- stem Design Results:
- oosite Steel Slab
- **3VLI22 steel decking**
- 5" total thickness
- Reduced floor weight from 42 psf to 35 psf
- Dosite W-Flange Steel Beam W14x26 (w/16 shear studs) Redesign lighter than Existing (by 5 lb)
- bosite W-Flange Steel Girder W18x35 (w/ 20 shear studs) Same weight as existing, less studs

- W-Flange Steel Columns
 - W10 shapes used for easy spliced connections
 - Sizes range from W10x33 to W10x60
 - Design relatively similar to Existing

Seismic Weight Comparison (Los Angeles, CA)					
Existing Building Design New Building Design					
Building Weight	26,045 kips	21,527 kips			
Base Shear	7918 kips	6550 kips			
Total Moment	Total Moment 423,898 ft-k 350,694 ft-k				

easy spliced connections 0x33 to W10x60 ar to Existing



- Lead-Core Rubber Base Isolation:
 - Increases building period •
 - Reduces building lateral drift
 - Incorporation of lead core dampens seismic forces and re-aligns building after quake

Seismic Base Isolation Comparison (Los Angeles, CA)					
	No Base Isolation Base Isolation				
Building Period	1.4754 sec	4.1803 sec			
Base Shear	6550 kips	6550 kips			
Total Moment	350,694 ft-k	350,694 ft-k			
Displacement (@ 90')	2.971"	2.64"			
Drift (@90')	0.025"	0.018"			
Member Size	W14x370	W14x283			

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Lateral Force Resisting System





- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments



Wind Variabl	ASCE Reference		
Basic Wind Speed	V	115mph	Fig. 26.5-1B
Directional Factor	K _d	0.85	Tab. 26.6-1
Occupancy Category			Tab. 1.5-1
Exposure Category		В	Sec. 26.7.3
Exposure Classification		Enclosed	Sec. 26.2
Building Natural Frequency	n ₁	0.833 (flexible)	Eq. 26.9-4
Topographic Factor	K _{zt}	1	Fig. 26.8-1
Velocity Pressure Exposure Coefficient evaluated at Height Z	Kz	varies	Tab. 27.3-1
Velocity Pressure at Height Z	q _z	varies	Eq. 27.3-1
Velocity Pressure at Mean Roof Height	q _h	23.96	Eq. 27.3-1
Gust Effect Factor	G	0.859	Eq. 26.9.5
Product of Internal Pressure Coefficient and Gust	<u> </u>	0.18	Tab 20 11 1
Effect Factor	GC _{pi}	-0.18	Tab. 26.11-1
External Pressure Coefficient (Windward)	C _p	0.8	Fig. 27.4-1
External Pressure Coefficient (Leeward)	Cp	-0.5 (Symmetric, L/B = 1.0)	Fig. 27.4-1

Lateral Force Resisting System

Seismic Design Variables		No Base I	solation	Base Is	solated	ASCE Reference
Site Class		C)		D	Sec. 20.3.2
Occupancy Category			I	I	II	Sec. C1.5.1
Importance Factor		1.2	25	1.	25	Tab. 1.5-2
Structural System		Steel Special C Braced	-		Concentrically Frames	Tab. 12.2-1
Spectral Response Acceleration, short	Ss	2.4	32	2.4	432	Fig. 22-1
Spectral Response Acceleration, 1s	S ₁	0.8	53	0.8	353	Fig. 22-2
Site Coefficient	Fa	1			1	Tab. 11.4-1
Site Coefficient	F _v	1.	5	1	.5	Tab. 11.4-2
MCE Spectral Response Acceleration, short	S _{ms}	2.4	32	2.4	432	Eq. 11.4-1
MCE Spectral Response Acceleration, 1 s	S _{m1}	1.2	79	1.2	279	Eq. 11.4-2
Design Spectral Acceleration, Short	S _{ds}	1.6	22	1.6	522	Eq. 11.4-3
Design Spectral Acceleration, 1 s	S _{d1}	0.8	53	0.8	353	Eq. 11.4-4
Seismic Design Category	S _{dc}	E			E	Sec. 11.6
Response Modification Coefficient	R	6.	0	6	.0	Tab. 12.2-1
Building Height (above grade) (ft)	h _n	9	C	9	90	
		North/South	East/West	North/South	East/West	
Approximate Period Parameter	Ct	0.02	0.02	0.02	0.02	Tab. 12.8-2
Approximate Period Parameter	х	0.75	0.75	0.75	0.75	Tab. 12.8-2
Calculated Period Upper Limit Coefficient	C _u	1.4	1.4	1.4	1.4	Tab. 12.8-1
Approximate Fundamental Period	T _a	0.584	0.584	0.584	0.584	Eq. 12.8-7
Fundamental Period	Т	1.4081	1.4754	4.1803	4.1866	Sec. 12.8.2
Long Period Transition Period	TL	8	8	8	8	Fig. 22-12
Seismic Response Coefficient	C _s	0.304	0.304	0.304	0.304	Eq. 12.8-2
Structural Period Exponent	k	1.042	1.042	1.042	1.042	Sec. 12.8.3

Wind Design Variables

Seismic Design Variables

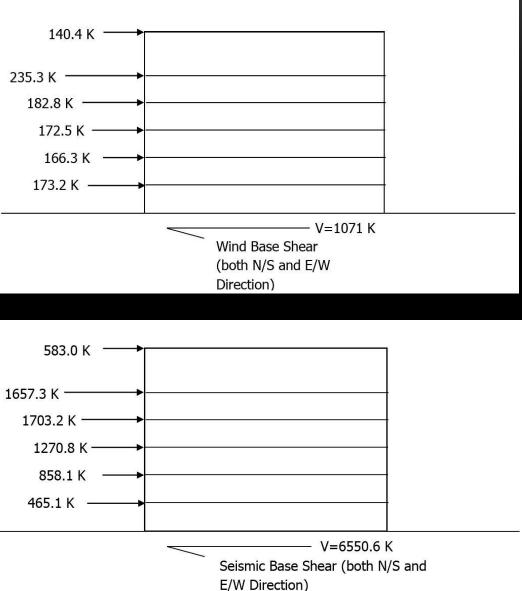


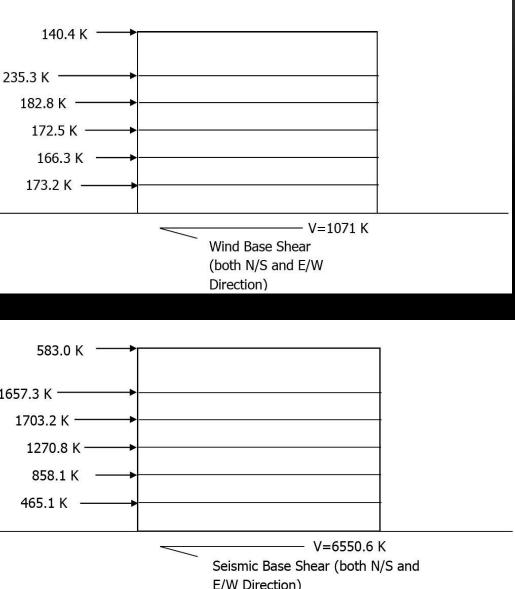
- Design Loads:
 - ASCE 7-10
- Serviceability Criteria: Drift Criteria
 - $\Delta_{Wind} = H/400$
 - $\Delta_{\text{Seismic}} = 0.02 H_{\text{sx}}$
- Controlling Load Combination:
 - 1.2D + 1.0E + 1.0L

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Lateral Force Resisting System

- Wind Loads (Directional Method)
- Seismic Loads (Equiv. Lat. Force Method)





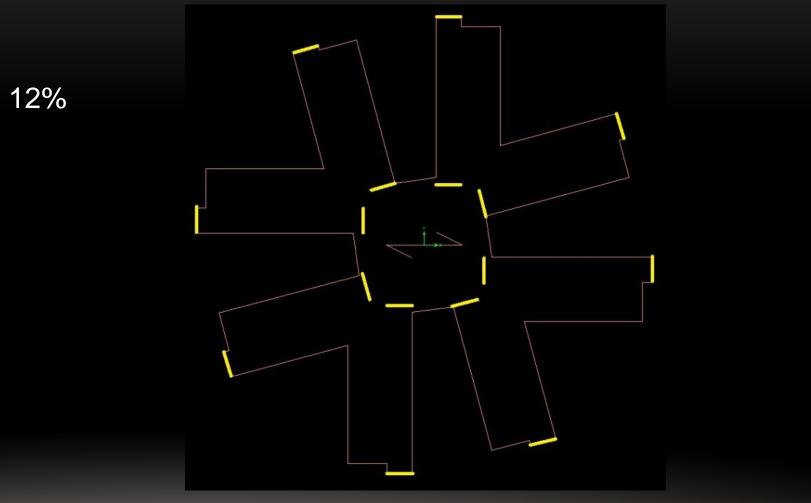
- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments



Frame Stiffness:

 Equally about 12% contribution

Lateral Force Resisting System



Relative Story Stiffness: X Direction

			R	elative Sto	ory Stiffnes	s Ratio (R _{ii}	.)			
P = 1000 kips										
	Frame #	A1	A8	B9	B15	C1	C8	D9	D15	
X-Direction Displacement Δ _p (in)	Pent. RF	4.127	4.173	-	-	-	-	-	-	
	Pent. FL	3.147	3.130	3.104	3.117	3.100	3.117	3.144	3.130	
	4	2.147	2.126	2.093	2.110	2.089	2.110	2.144	2.126	
-DiSpla	3	1.317	1.296	1.264	1.280	1.260	1.280	1.313	1.296	
Di ^	2	0.665	0.652	0.632	0.642	0.629	0.642	0.663	0.652	
	1	0.263	0.257	0.246	0.252	0.245	0.252	0.262	0.257	
	Frame #	A1	A8	B9	B15	C1	C8	D9	D15	ΣK _{ix}
sss /in)	Pent. RF	242.3068	239.6358	-	-	-	-	-	-	481.9425
Story Stiffness K _{ix} = P/Δ _p (kip/in)	Pent. FL	317.7848	319.4888	322.2065	320.8316	322.5494	320.7801	318.056	319.4786	2561.176
/ Sti /Δ₀	4	465.812	470.4775	477.7374	474.001	478.675	473.8663	466.5267	470.3226	3777.419
tor) = P	3	759.5806	771.9027	791.4523	781.3721	793.9659	781.0059	761.4406	771.5454	6212.266
K S	2	1504.352	1534.684	1583.03	1558.118	1589.572	1557.147	1508.978	1533.742	12369.62
	1	3796.522	3897.116	4060.089	3974.563	4081.633	3972.984	3812.429	3894.081	31489.42
									Σk _{ix,total} :	56891.84
	Frame #	A1	A8	B9	B15	C1	C8	D9	D15	
tal Ci ≺	Pent. RF	0.502771	0.497229	-	-	-	-	-	-	
Relative Story Stiffness Ratio R _{ix} = K _{ix} /K _{ix,total}	Pent. FL	0.124078	0.124743	0.125804	0.125267	0.125938	0.125247	0.124184	0.124739	
ive : ess K _{ix} /I	4	0.123315	0.12455	0.126472	0.125483	0.12672	0.125447	0.123504	0.124509	
elat iffn _{ix} =	3	0.122271	0.124255	0.127402	0.125779	0.127806	0.12572	0.122571	0.124197	
Rel: Stiff R _{ix}	2	0.121617	0.124069	0.127977	0.125963	0.128506	0.125885	0.121991	0.123993	
	1	0.120565	0.12376	0.128935	0.126219	0.129619	0.126169	0.12107	0.123663	
Average		0.122369	0.124275	0.127318	0.125742	0.127718	0.125694	0.122664	0.12422	

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

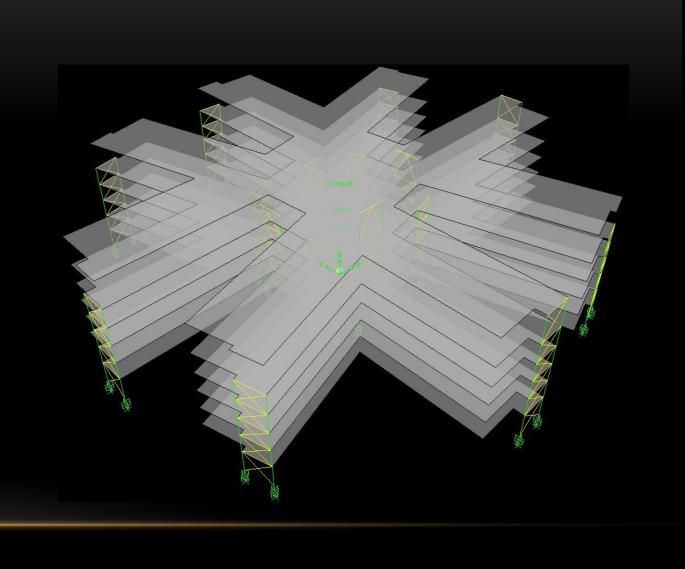
Lat	le	ra	F	-(

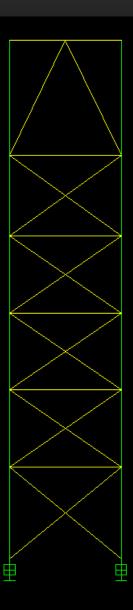
Controlling Seismic Drift (x-direction)									
Floor	Story Drift (in)	Allowable Story Drift (in)	Is this OK?						
Roof	0.0184	0.400	yes						
PH Floor	0.0152	0.280	yes						
4th Floor	0.0168	0.267	yes						
3rd Floor	0.0156	0.267	yes						
2nd Floor	0.0123	0.267	yes						
1st Floor	0.0073	0.320	yes						

Floor	
Roof	
PH Floor	
4th Floor	
3rd Floor	
2nd Floor	2.
1st Floor	8

orce Resisting System

Controlling Wind Displacement (x-direction)									
Height above Ground (ft)	Displacement (in)	Allowable Displacement (in)	ls this OK?						
90	2.523	2.700	yes						
70	1.519	2.100	yes						
56	1.127	1.680	yes						
42.667	0.751	1.280	yes						
29.333	0.413	0.880	yes						
16	0.153	0.480	yes						







Mechanical System:

- Variable Air Volume (VAV) system \bullet
- 12 separate AHU's
- Energy Recovery Wheels used for resident rooms \bullet

Buffalo, NY:

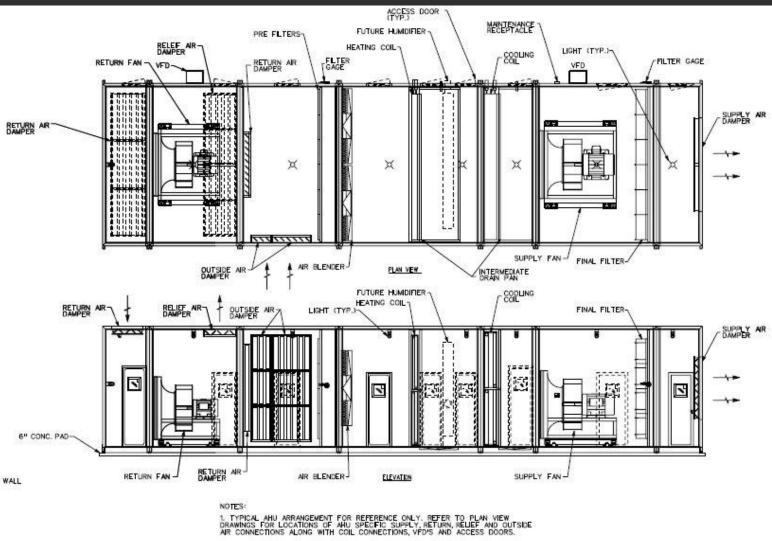
- Summer: 86°F • Winter: 1°F

- 1. Project Background 2. Scope of Work 3. Structural Depth Study Foundation System İ. ii. Gravity System iii. Lateral Force Resisting System 4. Mechanical Breadth 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

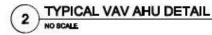
Mechanical Breadth

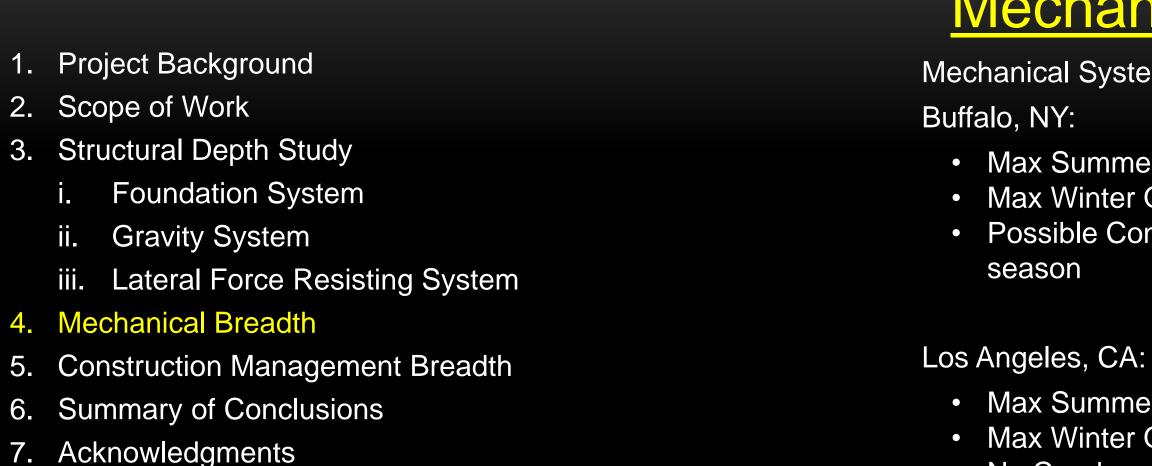
Los Angeles, CA:

- Summer: 84°F
- Winter: 43°F



2. ALL AHU'S SHALL BE PROVIDED WITH BLANK HUMDIFER SECTION FOR FUTURE HUMDIFIER DISPERSION TUBES EXCEPT AHU-G-B AND AHU-G-D

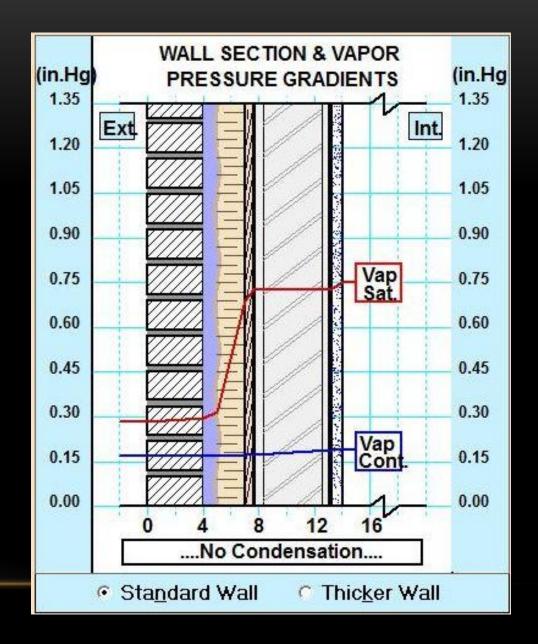




Max Summer Q_s: 7,988,607 BTU/hr Max Winter Q_s: 34,202,119 BTU/hr No Condensation

Mechanical Breadth

- Mechanical System Results:
- Max Summer Q_s: 8,189,038 BTU/hr • Max Winter Q_s: 38,411,170 BTU/hr Possible Condensation within Wall Cavity in Summer





- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Cost Analysis:

Component
WF Lateral Steel Colum
HSS Steel Bracing
HP Steel Piles
Lead Rubber Base Isolat

Construction Management breadth

• Project Cost increased by roughly 6% Primarily due to addition of LRB Isolators

	Quantity	Lab	or	Mate	rial	TOTALS			
	Quantity	Unit Cost Amount Unit		Unit Cost	Amount	Redesigned	Original Design		
ns	138.183 TN	33 TN 715.68/TN 196,784 2,074.64/TN		286,674	\$385,567	\$118,605			
	30.3 TN	715.65/TN	21,684	2,074.64/TN	62,862	\$84,726	\$95,099.00		
	30720 VLF	17.47.	116	44.25/VLF	1,359,360	\$1,359,360	70		
ors	207	1900	2	20,000/LRB	4,140,000	\$4,140,000	-		
	2			10	TOTALS	\$5,969,653	\$213,704		

05-00-00		METALS			
05-00-00		METALS			
	85	MISC METAL ALLOWANCE	1.00	LS	
		METALS			
		275,000.00 GSF			
		0.003 Equipment hours			
05-10-00		Structural Metal Framing			
	05	WF STEEL COLUMN	274,960	TN	715.682 /TN
	10	HSS STEEL COLUMN	34.082	TN	715.653 /TN
	40	STRUCT FLOOR FRAMING	809.42	TN	716.031 /TN
	40	STRUCT FLOOR FRAMING - TUBE STEEL AT	48.07	TN	716.04 /TN
		FINS			
		STRUCT FLOOR FRAMING	57.42	TN	716.04 /TN
	10.000	STRUCT ROOF FRAMING	214.50	TN	716.041 /TN
		MOMENT CONNECTIONS	33.00	EA	524.034 /EA
		MISC. CONNECTIONS AT FLOOR	121.413		947.33 /TN
	70	MISC, CONNECTIONS AT FLOOR - TUBE STEEL AT FINS	7.21	TN	947.38 /TN
	70	MISC. CONNECTIONS AT FLOOR	8.612	TN	947.38 /TN
	10.000	MISC. CONNECTIONS AT ROOF	32.97	TN	947.38 /TN
			3.893.00	EA	1.91 /EA
	100		16.737.14		6.522 /LF
	135	HUNG LINTELS	482.00		20.38 /LF
	135	LOOSE LINTELS @ MASONRY	3,440.00	LF	12.67 /LF
		Structural Metal Framing		50	5.012/GSF
		275,000.00 GSF			
		20.822.27 Labor hours			
		2,462.331 Equipment hours			

_

5 3	. (1 00 <u>0</u>	53,625	53,625.00 /LS	53,625
			53,625	0.20 /GSF	53,625
196,784	2.074.644 /TN	570,444		2.790.33 /TN	767,228
24,391	2,074.644 /TN	70,708	1	2,790.30 /TN	95,099
579,569	2.074.66 /TN	1,679,270	-	2,790.69 /TN	2,258,840
34,419	2,074.66 /TN	99,725	12	2,790.70 /TN	134,143
41,111	2,074.66 /TN	119,117	25	2,790.70 /TN	160,228
153,589	2,074.66 /TN	445,010		2,790.70 /TN	598,599
17,293	322.04 /EA	10,627	<u>1</u>	846.072 /EA	27,920
115,018	2,173.421 /TN	263,882		3,120.75 /TN	378,899
6,831	2,173.422 /TN	15,670	12	3,120.80 /TN	22,501
8,159	2,173.423 /TN	18,718		3,120.80 /TN	26,876
31,235	2,173.421 /TN	71,658	2	3,120.80 /TN	102,893
7,428	1.072 /EA	4,175		2.98 /EA	11,603
109,158	12.83 /LF	214,743	<u> </u>	19.352 /LF	323,901
9,823	20.183 /LF	9,728		40.562 /LF	19,551
43,584	12.55 /LF	43,166		25.22 /LF	86,750
1,378,391	13.224/GSF	3,636,641	25	18.24 /GSF	5,015,032



- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Schedule Impact:

- Project Schedule increased by 170 days Primary Impact: installation of Pile Foundations • 2 week setback due to installation of LRB isolators

Construction Management breadth

	-	Task	Task Name	1st Ha						1st Ha						1st Ha		l
	0	Mode 🔻		Ist Qu Jan	arter Mar	May	3rd Qua Jul	Sep	Nov	1st Qu Jan	arter Ma	ar May	3rd Qu Jul	arter Sep	Nov	1st Qu Jan	Ma	ļ
41		8	- Area A	Jan	war	way	701	зер	NOV	Jan	I IVI	ar May	301	sep	NOV	Jan	Ma	1
42		*	Steel Shop Drawings / Fabrication					ř.										
43		*	Furnish / Deliver Anchor Bolts & Layout Plans			٠	6/15											
44		*	Foundation Contractor Mobilization				\$ 7/1	3										
45		*	Foundation Mobilization / Survey / Layout				0											
46		*	Drive Piles for Deep Foundation															
47		*	Concrete Foundations & Backfill															
48		*	Steel Contractor Mobilization					\$ 9/7										
49		*	Steel Erection (including metal deck)															
50		*	Steel Detailing					0										
51		*	Metal Stairs					0										
52		*	Roofing Deck & Vapor Barrier (temporary dry-in)	1														
53		*	Roof Drains / Leaders															
54		*	U/G Utilities															
55		*	Sleeves / Deck Prep															
56		*	Slab on Deck															
57		*	MEP Hanger Install	1														
58		*	SOG Stone / Prep						0									
59		*	SOG Pour						0									
60		*	Fireproofing						C									
61		*	Install of Sunshade Mounting Brackets	1														
62		*	Panelized Exterior Studs / Sheathing															
63		*	MEP Rough-In							_								
64		*	Set Mechanical Equipment						1									
65		*	Interior Metal Studs / Frames	1						C								
66		*	Hang Drywall							0								
67		*	Roofing Insulation / Membrane / Detailing															
68		*	Drywall Tape & Finish	1							Act		Barrowski	-		Orla E	arty	1
69		*	Paint / Wall Finishes								Act ID	truction	Descripti	un		Orig E Dur S	larly lart	l
70		*	Ceiling Grid								d Sched							
71		*	All Tile / Flooring							5		Stework & Site E Stework & Site E				0 07.JA 260 10.JA		2
72		*	Millwork							1	5 5	Stework & Site E	lectrical Bids	Due	2	0	1	į
73		*	MEP Finishes / Fixtures							2	0 5	Stework & Site E Stework Notice to	lectrical De-S			2d 16FE	EB11 1	ŝ
74		*	Interior Glazing							2	6 5	the Electrical Not	tice to Proce	ed			EB11	
75		*	Ceiling Tile							31		Foundation Notice Foundations Bid F		-	-		AN11 AN11 1	į.
76		*	F&B Equipment							4		Foundations Bilds Foundations De-S			3	0 20 18FE	EB11 2	ŝ
										4		ouncations De-S Foundations Notic		1	-	20 1011	LU15 2	í

			Early Finish	JAN PEB NAR APR NOV JAN AL AND BEP OCT NOV DEC JAN PEB NAR APR NOV JAN JAL AUG BEP OCT NOV DEC JAN PEB I	MAR
	0			N Stework 8.99 Ference Violise to Ritriers	
-		07JAN11 A 10JAN11	14FEB11	Stework & Ste Electrical Bid Period	
2	0		15FEB11		
-	20	16FEB11	17FEB11 31MAY11	I Steven & Site Electrica De-Coope © Otwark Notice to Proceed	
-	0	18FEB11	31/06/11	Spe Electrical Notice to Proceed	
3		20JAN11	8 8	Pouncada Netoe to Bidders	
-	200	20JAN11	16FEB11 17FEB11	Pointations Bid Period o Fountations Bids Due	
-	20	18FEB11	21FEB11	CPbundations De-Scope	
1	0		31MAY11		
- 3	200	17FEB11 17FEB11	16MAR11	S Shudural Steel & Elevators Notice to Bidders Soluctural Steel & Elevators Bid Percod	
	200	1/FED11	10MAR11	e Structural Steel & Elevators Bitts Due	
-	20	18MAR11	21MAR11	6 Structurel Steel & Elevators De-Scope	
1	0	28MAR11	31MAY11	Structural Steel & Elevators Notice to Proceed Structural Steel & Elevators Notice to Proceed Structural VAEP Notice to Bioders	
	34d	28MAR11	12MAY11	Skin / Interfor / MEP Bid Period Winter Conditions	
	0		12MAY11	Shin / Interior / MEP Bids Due Shin / Interior / MEP DeScope / Accronit	
	200	13MAY11	09JUN11 01JUL11	Sinh / Index / MEP De-Societ Approval	
			DISCUT		
1		13JUN11	10000	6 5/9 Contractor Mobilization IConstruction / Temporary Fercing	
-	2d 3d	13JUN11 15JUN11	14JUN11 17JUN11	gSte Survey / Stake-out	
	5d	17JUN11	23JUN11	Construction Entrances & Access Roads	
ation	20d	17JUN11 01JUL11	15JUL11 15JUL11	Removal of Contaminated Sols / Mass Busication	
-		11JUL11	22JUL11	Backtil / Compaction Work	
	60d	18JUL11	070CT11		
	5d	15AUG11	19AUG11	Removal of Natural Gas Pumping Station Complexity of Complexity Station	
-	10d	24AUG11 29MAR11	065EP11	Site Electrical Contractor Mobilization	
Work)		30MAR11	27MAY11	processing Re-Feed of CHCB (Inauding Utility Company Work)	
	200	13JUN11	27MAY11 11JUL11	Winter Conditions	
2		130UN11 030CT11	070CT11	Electrical conducts of hotbox"	
					111
1		01JUN11 15JUN11	31AUG11	Steel Shop Drawings / Patrication & Furnish / Deliver Anchor Bolts & Layout Flans	
		13JUL11	8 8	Foundation Contractor Mobilization	
	5d	13JUL11	19JUL11	Poundation Mobilization / Survey Layo	
	- 30d	20JUL11	30AUG11	Consete Foundations & Bejoidil	
1	0				
		07SEP11 07SEP11	040CT11	Teel Encodon (Inducting metal deck)	
	20d	07SEP11 05OCT11	01NOV11	minimum Steel Decaling	
	20d 20d 20d	07SEP11			





Foundation Redesign:

- HP 12x84 Grouped Steel Pile Deep Foundation Sufficiently designed for strength requirements Increased project cost and schedule

Gravity System Redesign:

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Summary of Conclusions

Composite Floor System

 Sufficiently designed for strength and Deflection requirements

Slightly Reduced Floor Weight

Maintained architectural floor layout

Lateral System Redesign:

- Concentrically Braced Frames
 - Sufficient Strength
 - Drift reduced due to LRB isolators
 - seismic
 - LRB isolators increased project cost and schedule

Mechanical Breadth:

• VAV mechanical system is adequate for new location

Construction Management Breadth:

- Cost was only increased by roughly 6%
- Project schedule was increased by 170 days

• Limited displacements and drifts due to wind and



- Cannon Design: Rachel Chicchi Douglas Flynn Brenda Onnen

- The Pennsylvania State University: • Prof. M. Kevin Parfitt • Prof. Robert Holland The entire AE faculty and staff

1. Project Background 2. Scope of Work 3. Structural Depth Study i. Foundation System ii. Gravity System iii. Lateral Force Resisting System 4. Mechanical Breadth 5. Construction Management Breadth 6. Summary of Conclusions 7. Acknowledgments

<u>Acknowledgements</u>

All my friends, family, and classmates for their continuous support and encouragement





Architectural Engineering

- 1. Project Background
- 2. Scope of Work
- 3. Structural Depth Study
 - i. Foundation System
 - ii. Gravity System
 - iii. Lateral Force Resisting System
- 4. Mechanical Breadth
- 5. Construction Management Breadth
- 6. Summary of Conclusions
- 7. Acknowledgments

Questions & Comments