Embassy Suites Hotel
Springfield, Virginia

Dominick Lovallo
Structural Option
AE Senior Thesis 2012 -2013
Thesis Advisor: Dr. Hanagan

Lobby Rendering

Presentation Overview

- **Presentation Overview**
- Introduction
- Existing Structural System
- Thesis Proposal
- Structural Depth
  - Proposed Solution
  - Gravity System Design
  - Lateral System Design
- Acoustical Breadth
- Conclusion

Proposed Building

Outline

- **Introduction**
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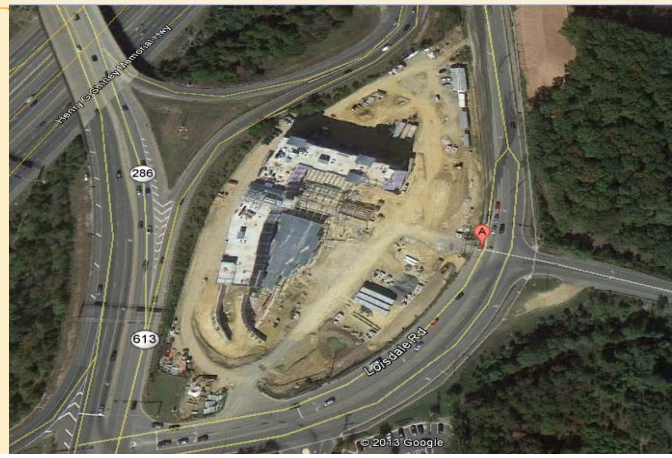
Building Introduction

- Location: Springfield, Virginia
- Owner: Miller Global Properties, LLC
- Architect: Cooper Carry
- General Contractor: Balfour Beatty Construction.
- Number of Stories: 7, 6 Above Grade (92 feet tall,)
- Size: 185,000 GSF
- Cost: $ 31.5 Million
- Construction: November 2011 – July 2013
- Delivery Method: Design-Bid-Build

Site Map



Outline

- Introduction
- **Existing Structural System**
  - **Foundation**
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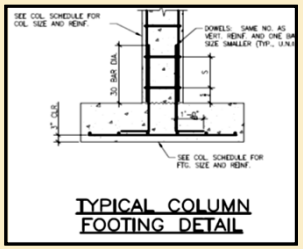
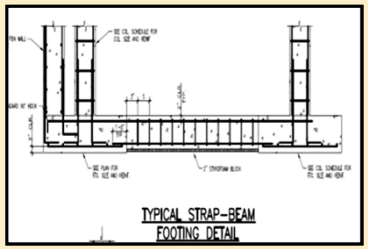
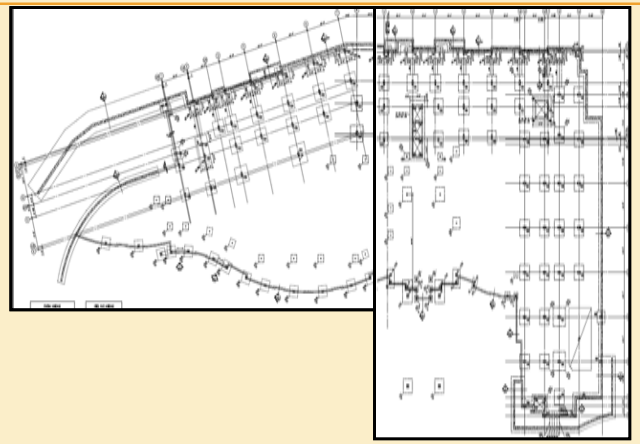
Existing Structural System

- **Foundation:**
  - Mud Mat System
  - Spread Footings
  - Strap Beams





Footing Layout



Outline

- Introduction
- **Existing Structural System**
  - Foundation
  - **Gravity / Lateral Load System,**
- Thesis Proposal
- Structural Depth
  - Proposed Solution
  - Gravity System Design
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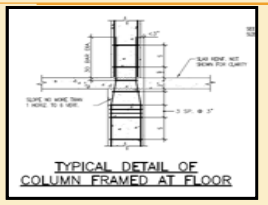
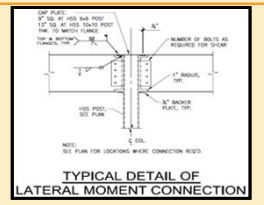
Existing Structural System

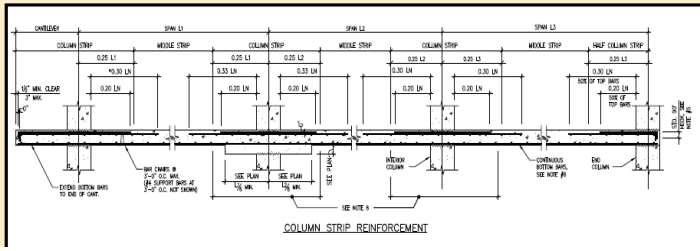
- **Gravity System:**
  - Floor – 8″ Concrete Reinforced Slab
  - 3.5″ Drop Panels
  - Columns: 14″ X 30″

- **Lateral System:**
  - Ordinary Concrete Moment Frames

Gravity / Lateral Details







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Thesis Proposal

- **Structural Depth**
  - Structural Redesign
    - Gravity Load Resisting System
    - Lateral Load Resisting System
- **Acoustical Breadth**
  - Measure STC Class of Typical Guest Room
    - Wall Partition
    - Floor Assemblies
- **Construction Breadth**
  - Construction Site Layout for Steel Erection Process
  - Specification of Construction Equipment

Outline

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Structural Depth

•Solution:

- Gravity System:
  - Floor System
  - Columns Design
- Lateral System:
  - Ordinary Steel Moment Frames

Outline

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    - **Floor Systems**
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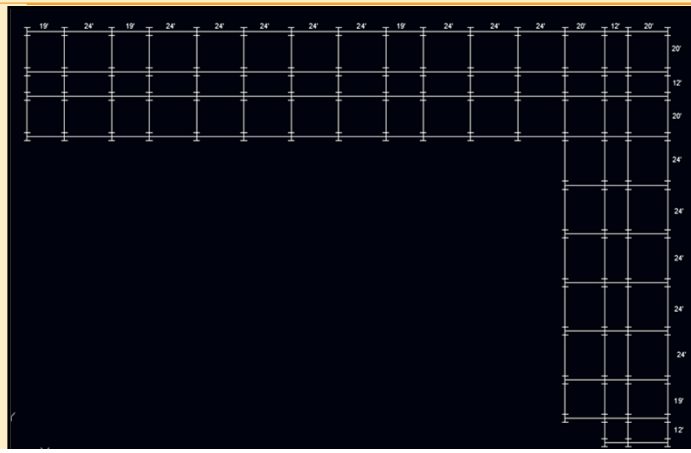
Structural Depth – Floor Design

- **Floor Systems**
  - Typical Bay 24′ x 20′
  - Dead & Live loads from ASCE 7 -05
  - Floor Systems
    - Slim Floor
    - Composite Floor

Floor Bay Layout



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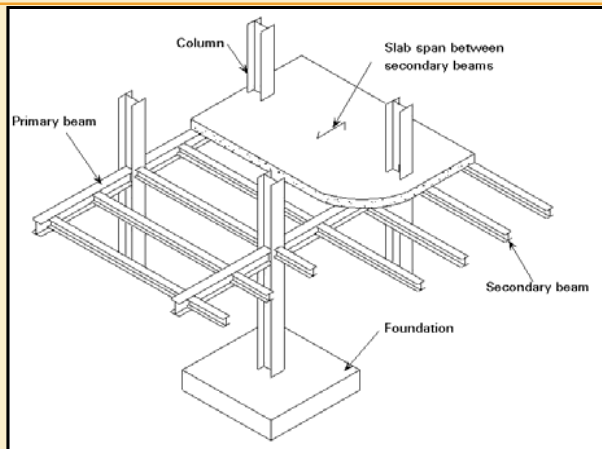
Structural Depth – Floor Design

- Composite Floor
  - Vulcraft 3 VLI 20 – 3.5 " toping thickness
    - Max Constr. Span 11' - 9" > 8 ' Clr. Span → OK √
    - Total Load 128psf < 251psf Max Allow. → OK √
- Beam Design
  - W 10 X 26
    - Max Allow. Deflection L/360 = .66" > .12 "→ OK √
    - Max Allow. Deflection L/ 240 = 1" > .457 → OK √

Composite Floor



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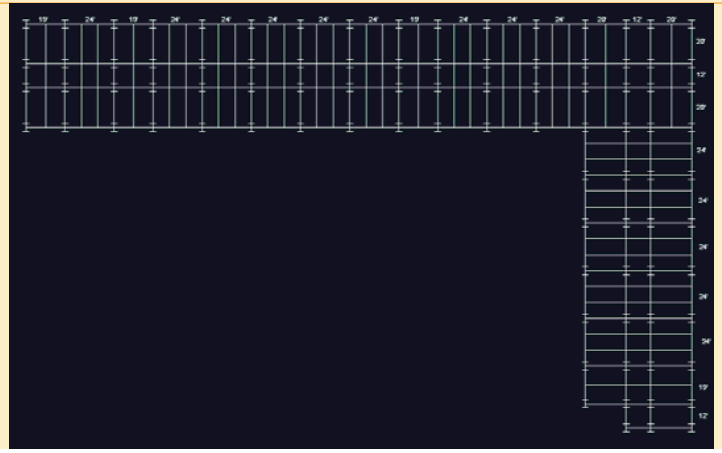
Structural Depth – Floor Design



Composite Floor Cross Section

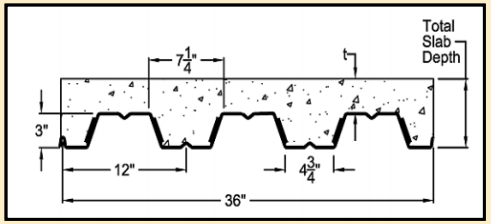


Figure: Vulcraft 3VLI 20 (Photo Taken From Vulcraft Catalogue)

Outline

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    - Floor Systems
    - **Column Design**
  - Lateral System Design
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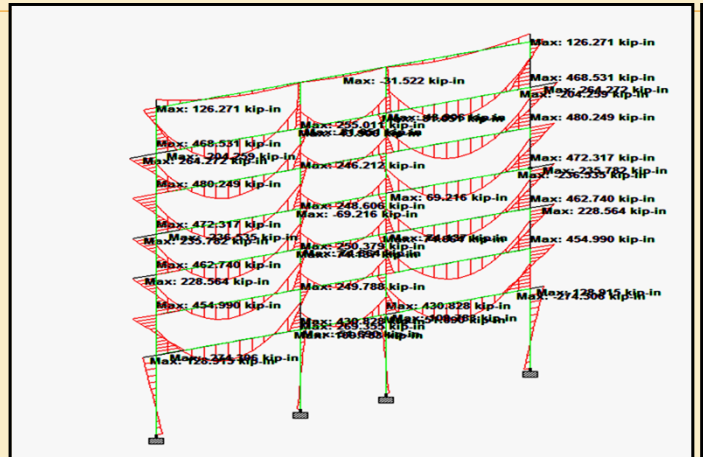
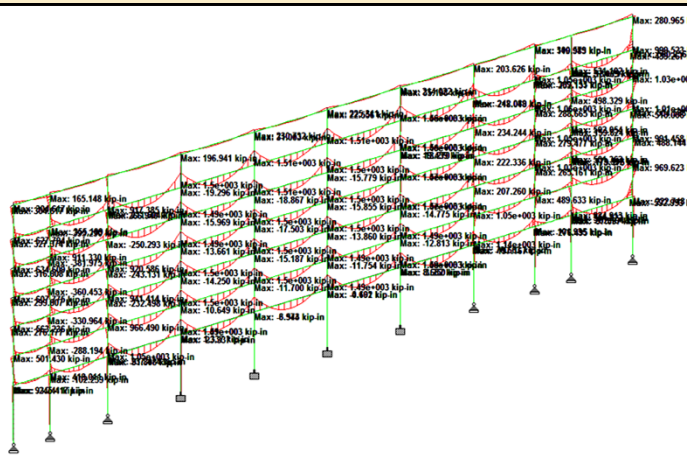
Structural Depth – Column Design



Computer Frame Analysis



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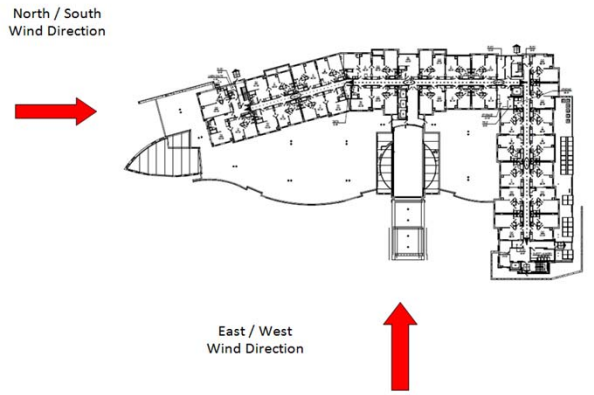
Structural Depth – Lateral System

- **Ordinary Steel Moment Frames:**
  - 3 Span Frames
  - One standard Column size
- **Assumptions:**
  - All columns will resist lateral load
  - Designed For Combined Gravity and Lateral Forces



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    - **Frame Design**
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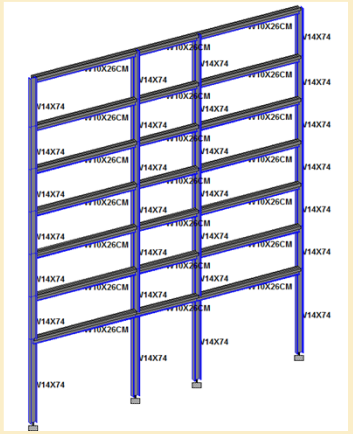
Structural Depth – Frame Design

- Frame Design
  - Direct Analysis Method
  - Combined Wind and Gravity
  - Controlling Load Combination (ASCE 7-05) –

$$1.2D + 1.6W + L + 0.5(L_r \text{ or } S \text{ or } R)$$

- Column Size – W 14 x 74

3 Bay Frame East / West Direction



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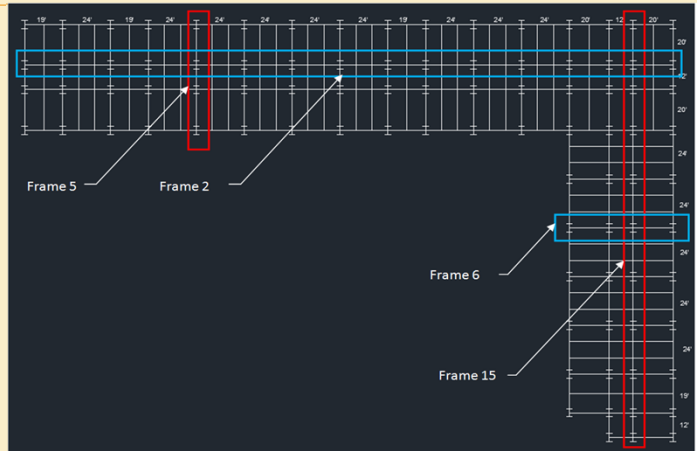
Structural Depth – Frame Design

- Wind Loading
  - Height Increase
  - ASCE 7 – 05 Wind Load Cases
  - Controlling Wind Direction East/ West
  - Controlling Load Case: Case 1
  - Base Shear = 411.7 K

Typical Frames



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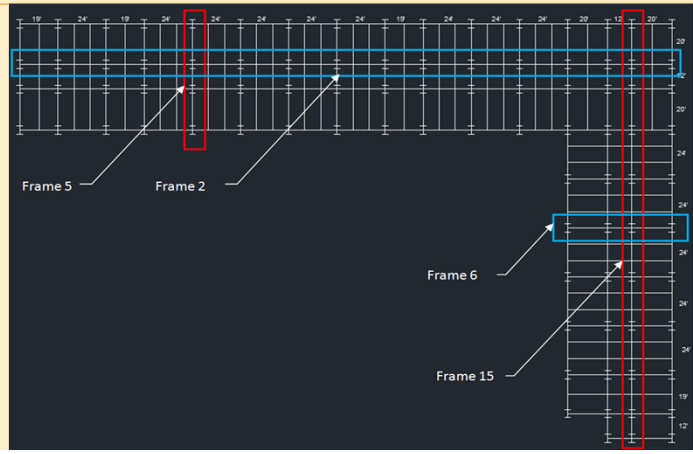
Structural Depth – Frame Design

- Seismic Loading
  - Recalculation of Building Weight
  - Original Response Modification Factor R= 3
  - Ordinary Steel Moment Frames R= 3.5
  - Base Shear Comparison

Seismic Analysis Comparison		
	Existing Building	Redesign
Weight	14202.5	8600(kip)
Base Shear	379.5	168 (kip)

Typical Frames



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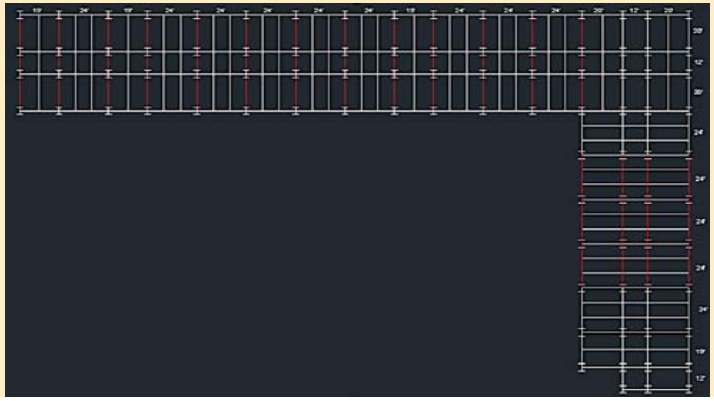
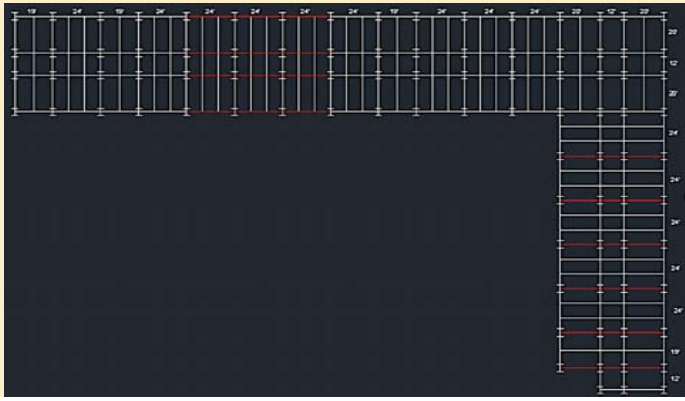
Structural Depth – Frame Design

Frames East / West Direction



Typical Frames

Frames North / South Direction



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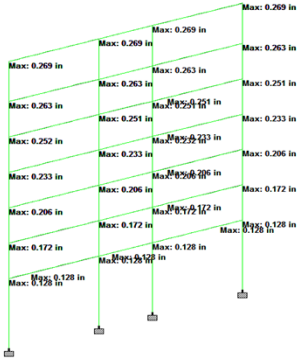
Structural Depth – Drift

- Drift Calculation
  - Wind Limitation – L/400
  - Seismic Limitation - .02h_{sx}

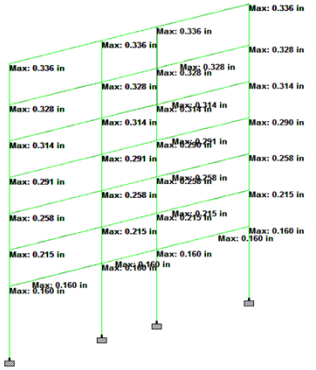
Direction	Lateral Force	Frame	Maximum Drift (in) Steel Frame	Drift Limit (in) Steel Frame
E/W	Wind	3 Bay	.462	2.33
E/W	Wind	10 Bay	1.03	2.33
N/S	Wind	3 Bay	.737	2.33
N/S	Wind	15 Bay	.326	2.33
E/W	Seismic	3 Bay	.269	1.12
E/W	Seismic	10 Bay	.291	1.12
N/S	Seismic	3 Bay	.326	1.12
N/S	Seismic	15 Bay	.4	1.12

3 Bay Frames Drift Values

- E/ W Direction



N/S Direction



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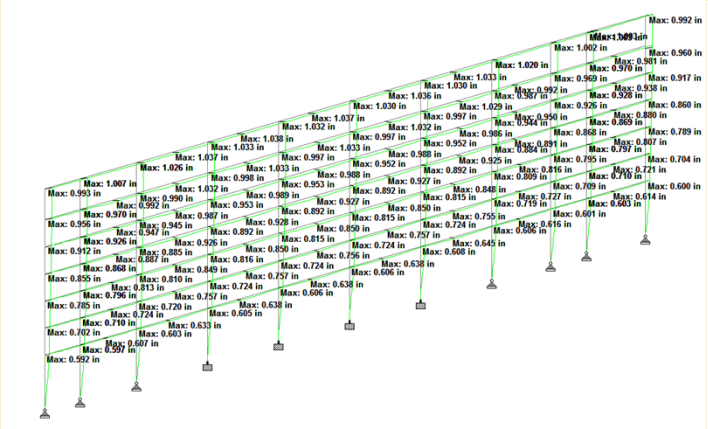
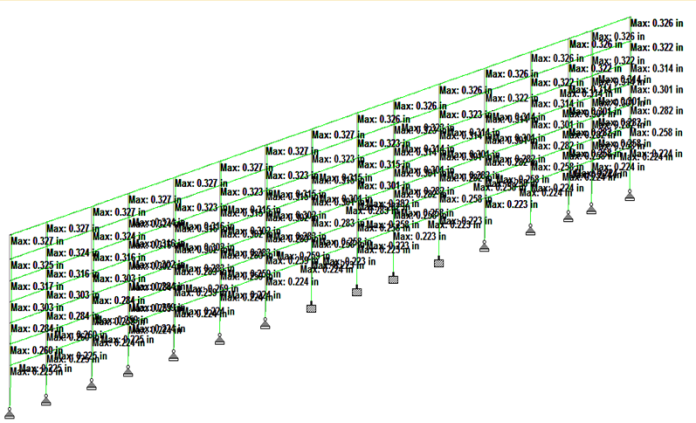
Structural Depth – Drift



10 and 15 Bay Frames Drift Values



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Acoustical Breadth

- Transmission Loss
  - TL = 10 log (1/τ)

- Sound Transmission Class
  - Single Number transmission loss value
  - Value in decibels (dB)
  - Measured in 1/3 Octave Bands from 125 to 4000 Hz
  - Determined by Plots

Transmission Loss Diagram

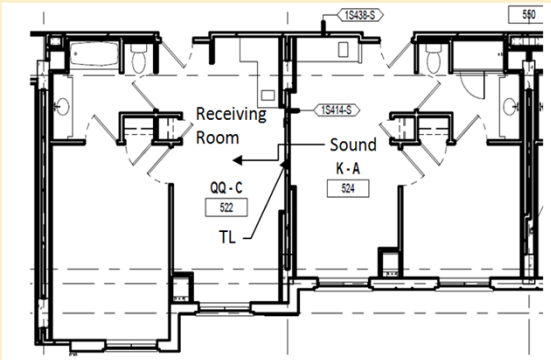

Figure: Typical Guest Room Layout

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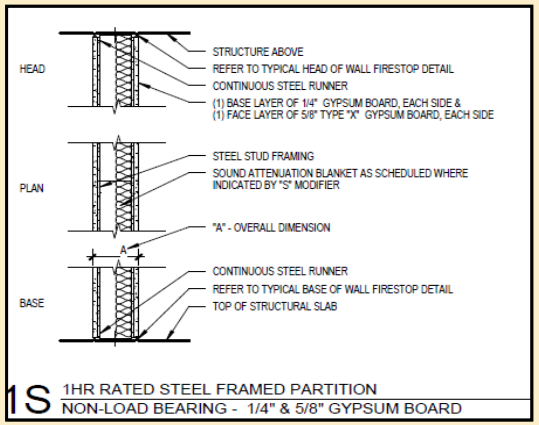
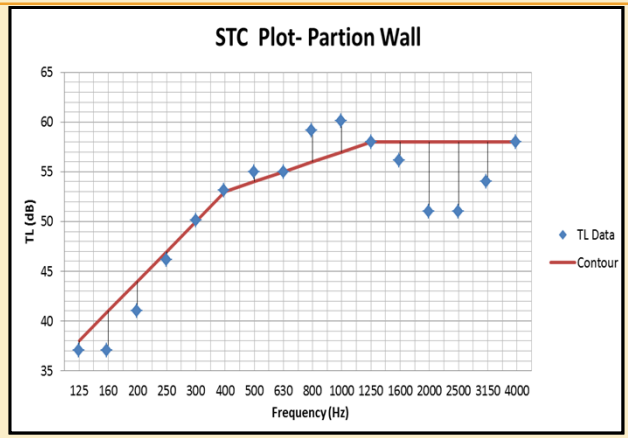
Acoustical Breadth



Transmission Loss Diagram



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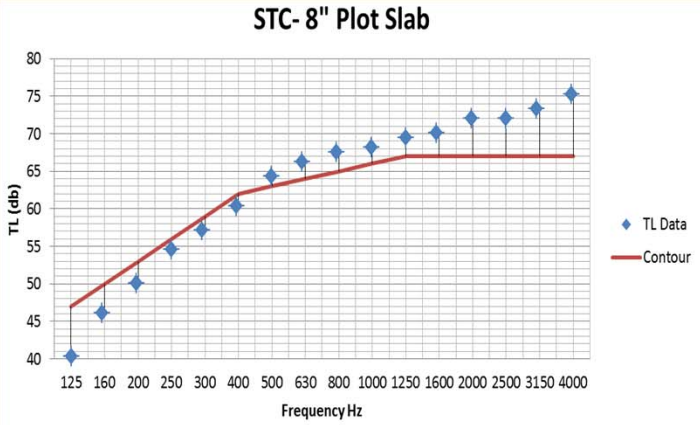
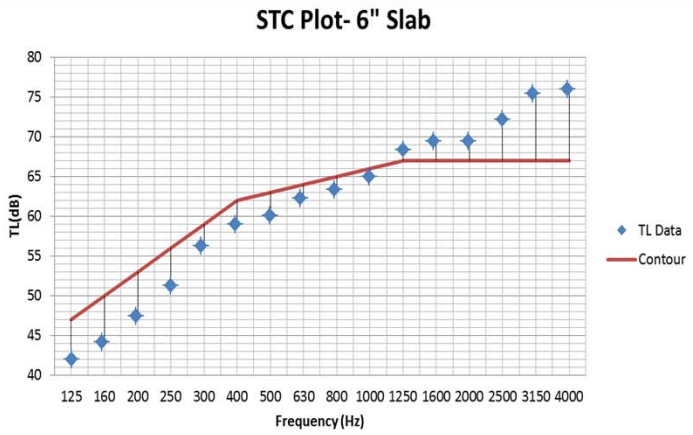
Acoustical Breadth



Transmission Loss Diagram



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Acoustical Breadth

- Kinetic Soundmatt
  - Floor Underlayment -5/16 " thickness

Transmission Loss Diagram

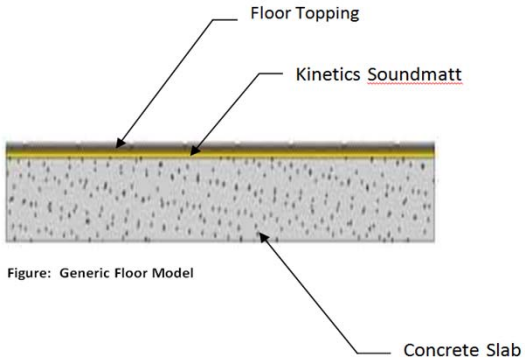


Figure: Generic Floor Model

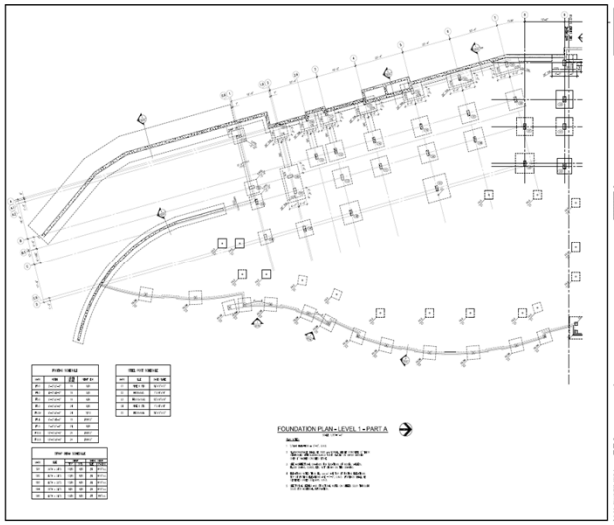
Conclusion

- Goals
  - Conditionally Structural Redesign is feasible
- Recommendations:
  - Foundation impacts would have to be examined

Questions/Comments

Acknowledgements:

- Balfour Beatty Construction
- Miller Global LLC
- Penn State AE Faculties
- Friends/Family



FOUNDATION PLAN - LEVEL 1 - PART A

SK&A

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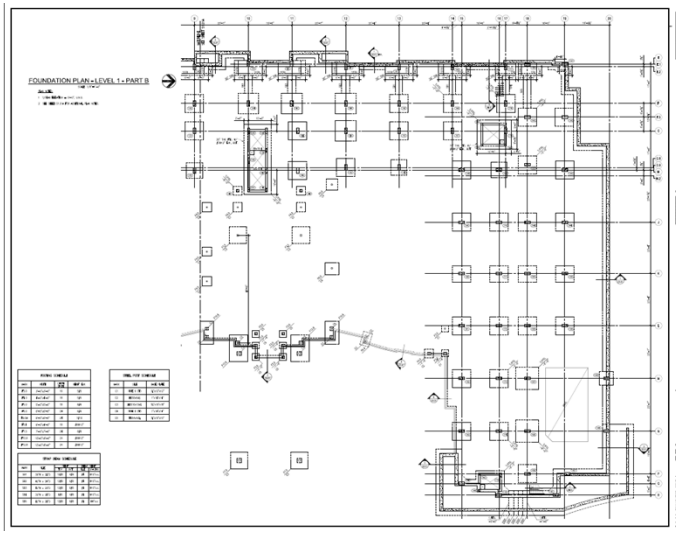
Washington, DC 20036
202-449-2520 (p)
202-449-1551 (f)
www.skaengineers.com

EMBASSY SUITES HOTEL

STRATFORD VA
FB PROPERTY, LLC

FOUNDATION PLAN
LEVEL 1 - PART A

S1.01A



FOUNDATION PLAN - LEVEL 1 - PART B

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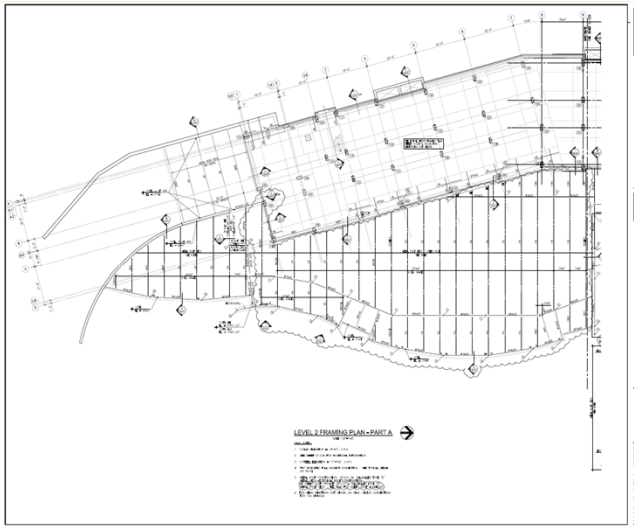
FOUNDATION PLAN
LEVEL 1 - PART B

S1.01B



LEVEL 2 FRAMING PLAN - PART A

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EMBASSY SUITES HOTEL

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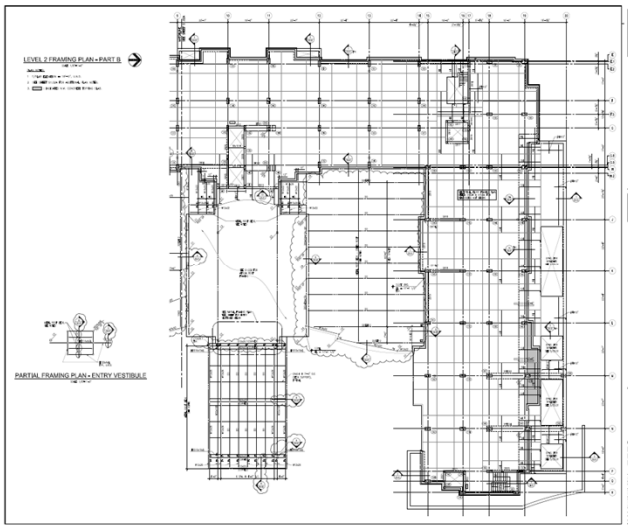
LEVEL 2
FRAMING PLAN -
PART A

S1.02A



LEVEL 2 FRAMING PLAN - PART B

PARTIAL FRAMING PLAN - ENTRY VESTIBULE

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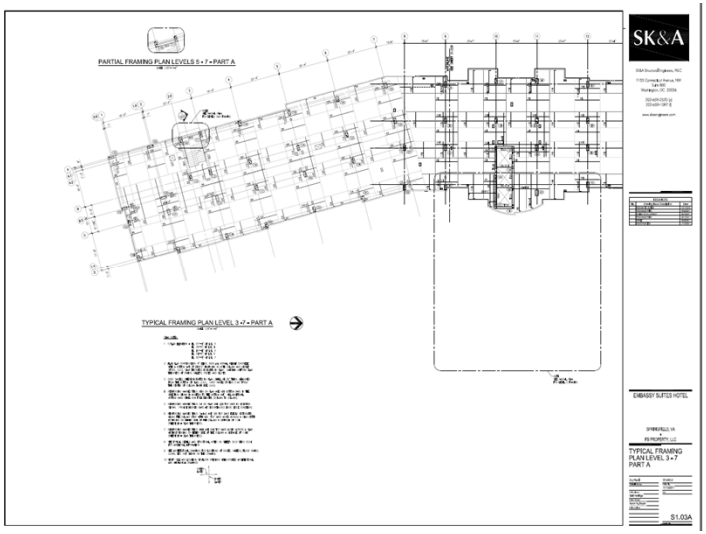
EMBASSY SUITES HOTEL

SPRINGFIELD, VA

FS PROPERTY, LLC

LEVEL 2
FRAMING PLAN -
PART B

S1.02B



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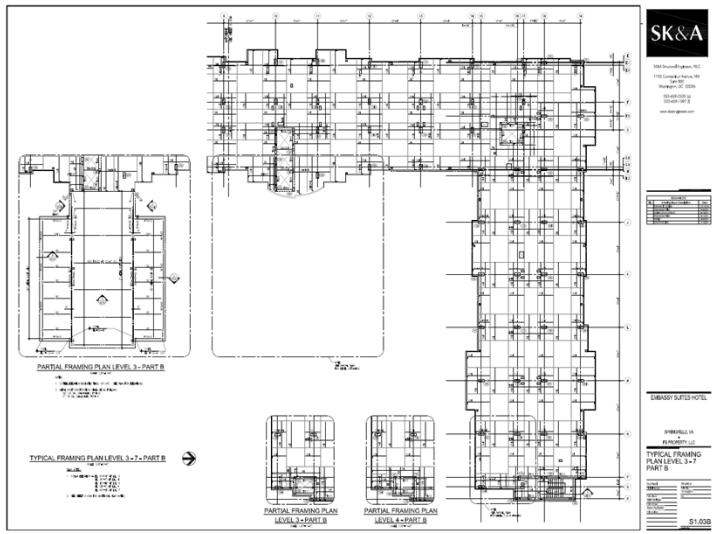
TYPICAL FRAMING PLAN LEVEL 3 +7 PART A

S1.03A



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EMBASSY SUITES HOTEL

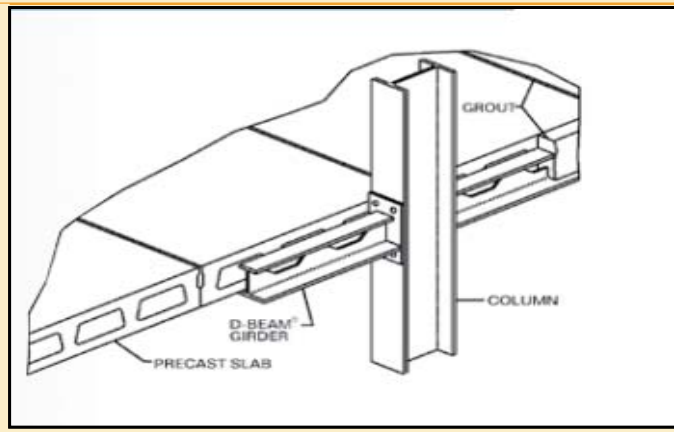
SPRINGFIELD, VA
for
PR PROPERTY, LLC

TYPICAL FRAMING PLAN LEVEL 3 +7 PART B

S1.03B

Structural Depth – Floor Design

- Slim Floor
  - Exceeded serviceability limitations
  - Feasible if larger dissymmetric beam and uniform bay size



Wind Tables

Floor	Story Pressure	Wind Direction	K Value- 3 Bay	K Value- 10 Bay	Total K Value	% Load to 3 Bay Frame	% Load to 8 Bay Frame	Load to 3 Bay	Load to 8 Bay
7th	60.30	E/W	23.8	58.8	521.0	0.0457	0.1129	2.8	6.8
6th	51.50	E/W	27.0	66.7	591.0	0.0457	0.1128	2.4	5.8
5th	50.30	E/W	31.3	71.4	660.7	0.0473	0.1081	2.4	5.4
4th	48.80	E/W	35.7	83.3	761.9	0.0469	0.1094	2.3	5.3
3rd	47.10	E/W	43.5	90.9	885.4	0.0491	0.1027	2.3	4.8
2nd	44.90	E/W	52.6	100.0	1031.6	0.0510	0.0969	2.3	4.4

Floor	Story Pressure	Wind Direction	K Value- 3 Bay	K Value - 15 Bay	Total K Value	% Load to 3 Bay Frame	% Load to 15 Bay Frame	Load to 3 Bay	Load to 15 Bay
7th	33.60	N/S	23.8	76.9	450.5	0.0528	0.1707	1.8	5.7
6th	28.60	N/S	27.0	90.9	525.8	0.0514	0.1729	1.5	4.9
5th	27.80	N/S	31.3	100.0	587.5	0.0532	0.1702	1.5	4.7
4th	26.90	N/S	35.7	100.0	614.3	0.0581	0.1628	1.6	4.4
3rd	25.80	N/S	43.5	111.1	705.3	0.0616	0.1575	1.6	4.1
2nd	24.50	N/S	52.6	125.0	815.8	0.0645	0.1532	1.6	3.8

Lateral Wind Force E/W Direction Case 1

Level	Load to 3 Bay	Load to 10 Bay	Frame 5	Frame 15	Total Lateral (Kip)	
7th	2.76	6.81	-1.00	2.87	1.76	9.68
6th	2.36	5.81	-0.96	2.09	1.40	7.90
5th	2.38	5.44	-0.97	1.92	1.41	7.36
4th	2.29	5.34	-0.93	1.92	1.36	7.26
3rd	2.31	4.84	-0.93	1.73	1.38	6.57
2nd	2.29	4.35	-0.92	1.55	1.37	5.90

Lateral Wind Force N/S Direction Case 1

Level	Load to 15 Bay	Load to 3 Bay	Frame 2	Frame 6	Total Lateral (Kip)	
7th	5.74	1.78	-2.91	0.85	2.83	2.63
6th	4.94	1.47	-2.51	0.72	2.43	2.19
5th	4.73	1.48	-2.35	0.71	2.38	2.19
4th	4.38	1.56	-2.08	0.72	2.30	2.28
3rd	4.06	1.59	-1.86	0.71	2.20	2.30
2nd	3.75	1.58	-1.68	0.69	2.07	2.27

Seismic Tables

Floor	Story Pressure	Wind Direction	K Value - 3 Bay	K Value- 8 Bay	Total K - Value	% Load to 3 Bay	% Load to 8 Bay	Load to 3 Bay	Load to 8 Bay
7th	13.00	E/W	23.8	58.8	521.0	0.0457	0.1129	0.6	1.5
6th	39.00	E/W	27.0	66.7	591.0	0.0457	0.1128	1.8	4.4
5th	38.80	E/W	31.3	71.4	660.7	0.0473	0.1081	1.8	4.2
4th	38.80	E/W	35.7	83.3	761.9	0.0469	0.1094	1.8	4.2
3rd	38.80	E/W	43.5	90.9	885.4	0.0491	0.1027	1.9	4.0

Floor	Story Pressure	Wind Direction	K Value - 3 Bay	K-Value 15 Bay	Total K - Value	% Load to 3 Bay	% Load to 15 Bay	Load to 3 Bay	Load to 15 Bay
7th	13.00	N/S	23.8	76.9	450.5	0.0528	0.1707	0.7	2.2
6th	39.00	N/S	27.0	90.9	525.8	0.0514	0.1729	2.0	6.7
5th	38.80	N/S	31.3	100.0	587.5	0.0532	0.1702	2.1	6.6
4th	38.80	N/S	35.7	100.0	614.3	0.0581	0.1628	2.3	6.3
3rd	38.80	N/S	43.5	111.1	705.3	0.0616	0.1575	2.4	6.1

Lateral Seismic Force E/W Direction

Level	Load to 3 Bay	Load to 10 Bay	Frame 5	Frame 15	Total Lateral (Kip)	
7th	0.59	1.47	-0.02	0.05	0.57	1.52
6th	1.78	4.40	-0.07	0.00	1.71	4.40
5th	1.84	4.19	-0.07	0.13	1.77	4.32
4th	1.82	4.24	-0.07	0.13	1.75	4.37
3rd	1.91	3.98	-0.07	0.13	1.84	4.11

Lateral Seismic Force N/S Direction

Level	Load to 15 Bay	Load to 3 Bay	Frame 2	Frame 6	Total Lateral (Kip)	
7th	2.22	0.69	-0.09	0.03	2.13	0.72
6th	6.74	2.00	-0.20	0.06	6.54	2.06
5th	6.60	2.06	-0.18	0.06	6.42	2.12
4th	6.32	2.26	-0.18	0.06	6.14	2.32
3rd	6.11	2.39	-0.18	0.06	5.93	2.45

Building Height and Floor Thickness Comparison						
Level	Existing Story Height (ft.)	Redesign Story Height (ft)	Percent Increase (%)	Floor Thickness Existing(in)	Floor Thickness Redesign(in)	Percent Increase (%)
7	10.375	11.09	6.4	3.25	11.8	72.4
6	9.125	9.61	5	11.5	16.8	35
5	9.125	9.61	5	11.5	16.8	35
4	9.125	9.61	5	11.5	16.8	35
3	9.125	9.61	5	11.5	16.8	35
2	9.125	9.61	5	11.5	16.8	35
1	18	18.48	2.6	11.5	16.8	35

	Total Story Height (ft)	**Overall Building Height(ft)**
Existing	74	91.82
Redesign	77.62	95.45

Freq (Hz)	TL (db)	Contour (dB)	Deficiency (dB)	Exceeds Max Deficiency
125	37	38	1	No
160	37	41	4	No
200	41	44	3	No
250	46	47	0	No
300	50	50	0	No
400	53	53	0	No
500	55	54	0	No
630	55	55	0	No
800	59	56	0	No
1000	60	57	0	No
1250	58	58	0	No
1600	56	58	2	No
2000	51	58	7	No
2500	51	58	7	No
3150	54	58	4	No
4000	58	58	0	No
		Total =	28	

Freq (Hz)	TL (dB)	Contour (dB)	Deficiency (dB)	Exceeds Max Deficiency
125	40	47	7	No
160	46	50	5	No
200	50	53	3	No
250	54	56	2	No
300	57	59	2	No
400	60	62	2	No
500	64	63	0	No
630	66	64	0	No
800	67	65	0	No
1000	68	66	0	No
1250	69	67	0	No
1600	70	67	0	No
2000	72	67	0	No
2500	72	67	0	No
3150	73	67	0	No
4000	75	67	0	No
		Total =	21	

Freq (Hz)	TL (db)	Contour (dB)	Deficiency (dB)	Exceeds Max Deficiency
125	42	47	5	No
160	44	50	6	No
200	47	53	6	No
250	51	56	5	No
300	56	59	3	No
400	59	62	3	No
500	60	63	3	No
630	62	64	2	No
800	63	65	1	No
1000	65	66	0	No
1250	68	67	0	No
1600	69	67	0	No
2000	69	67	0	No
2500	72	67	0	No
3150	75	67	0	No
4000	76	67	0	No
		Total =	34	