

SSM St. Clare Health Center

St. Louis County, MO

- Final Thesis Presentation
- Christopher Brandmeier
- Advisor: Dr. Aly Said, Dr. Linda Hanagan



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St. Louis County, MO

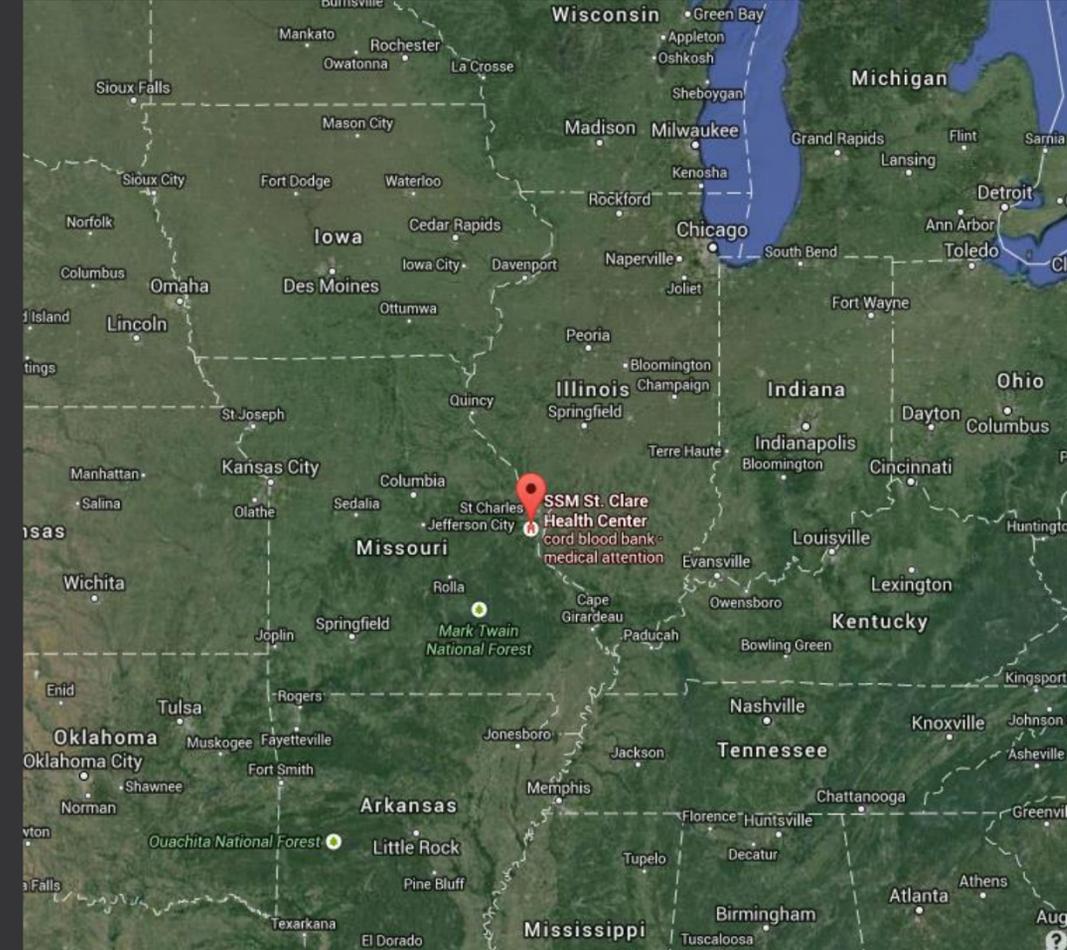
- **Overview of Site and Existing Structure**
- Depth: Flat Slab Construction
- Construction Breadth: Cost and Schedule
- Landscape Architecture Breadth: Force Protection Design
- Conclusion

Existing Site and Structure

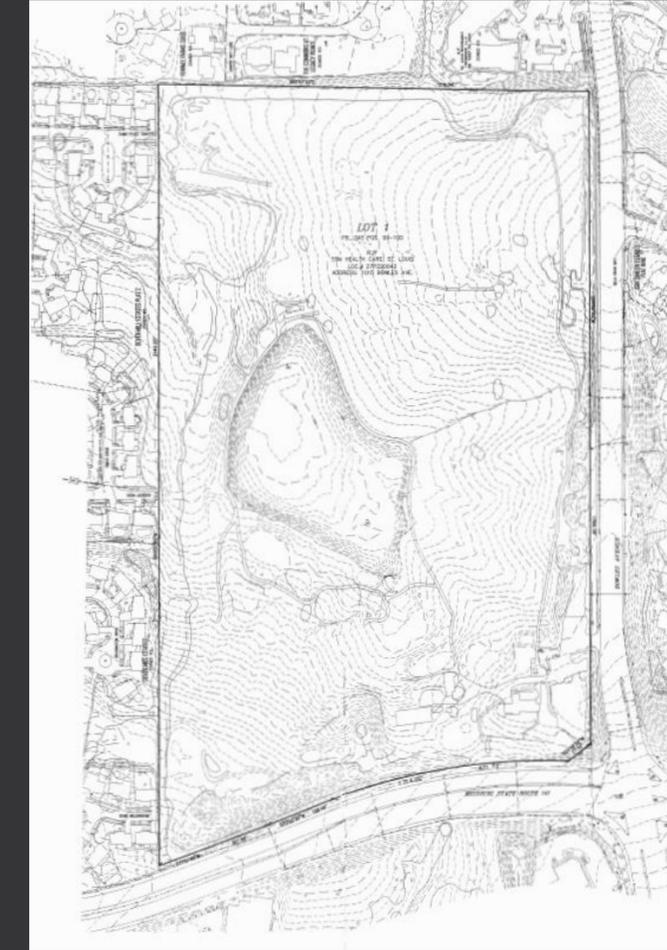
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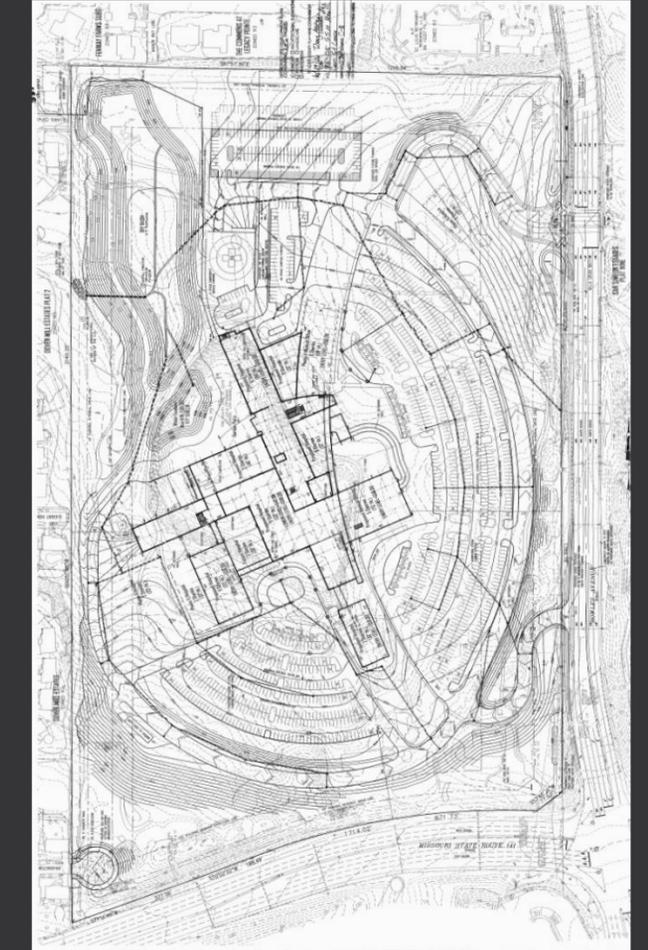
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Site Location



Pre-Construction

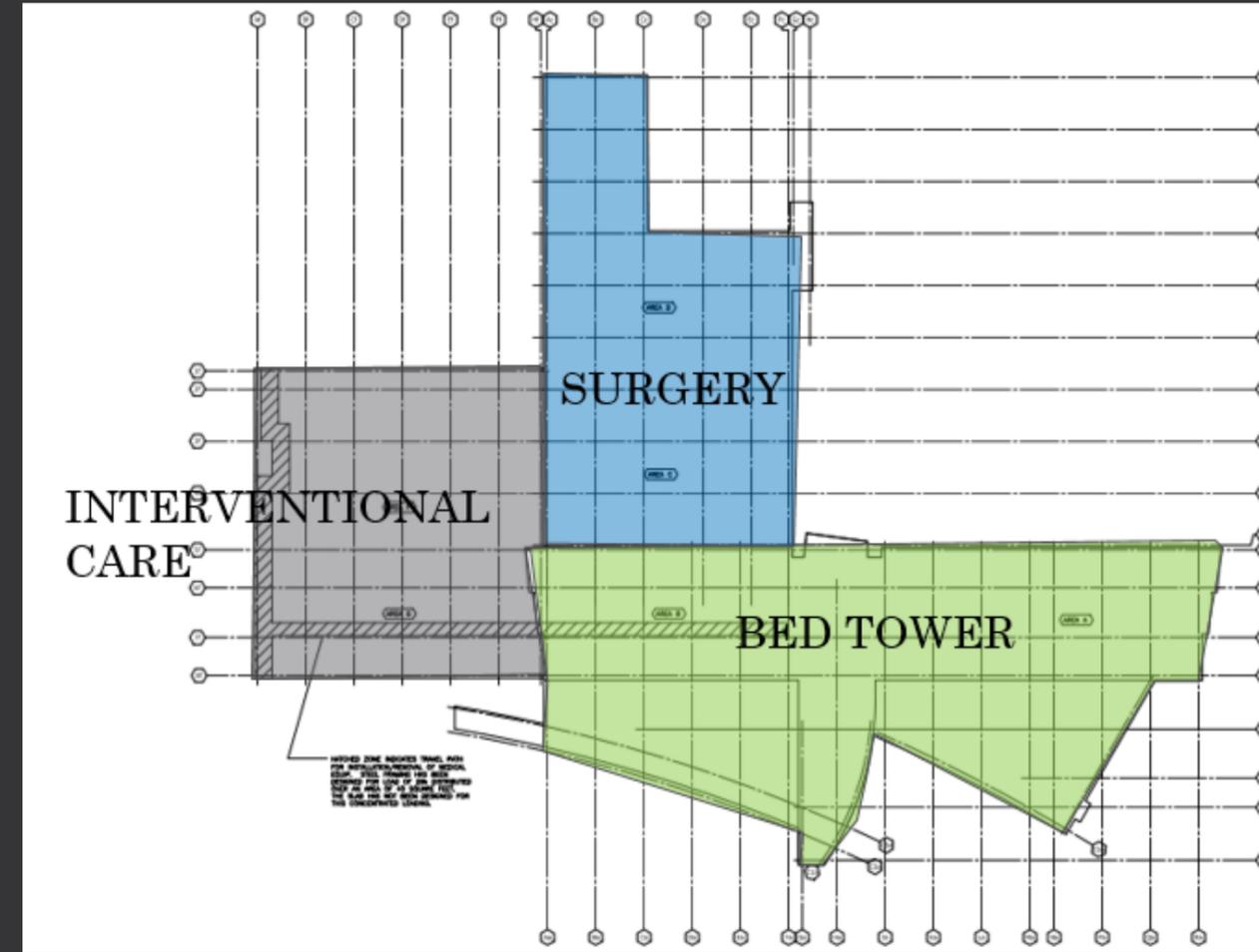


Post-Construction

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Structurally Isolated Building Segments



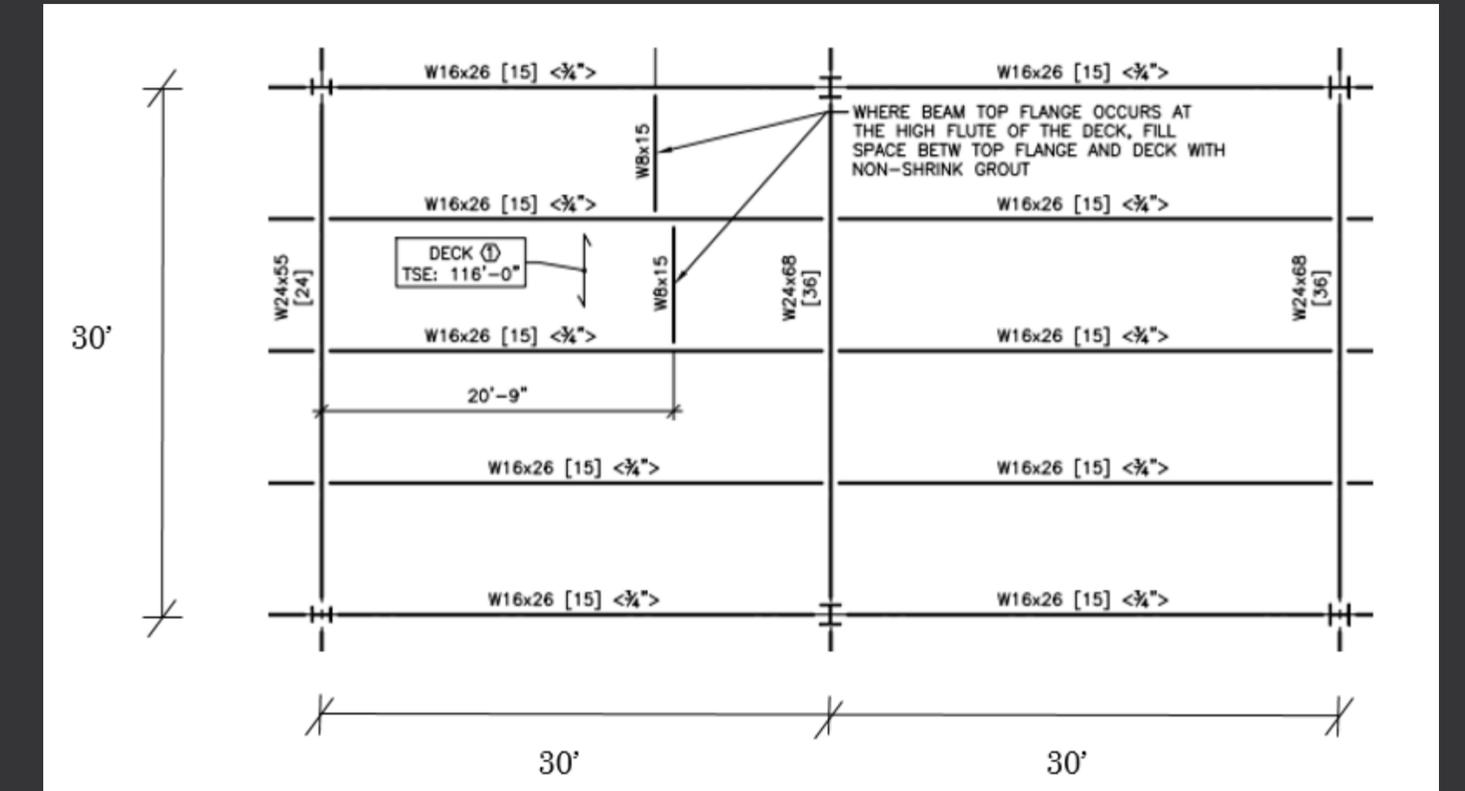
Structural Grid, Typical Bays

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- Composite Steel Frame
- W16x26 Beam
- W24x55 Girder
- 3” Composite Deck (typ.)
- 3” Lightweight Concrete Topping (typ.)



Typical Bay

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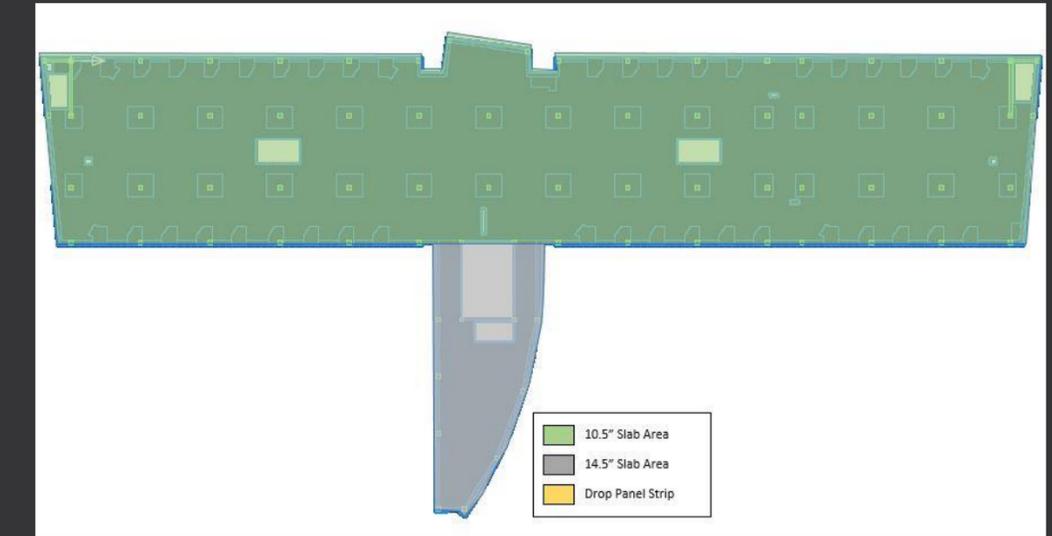
Structural Depth:
Flat Slab Construction

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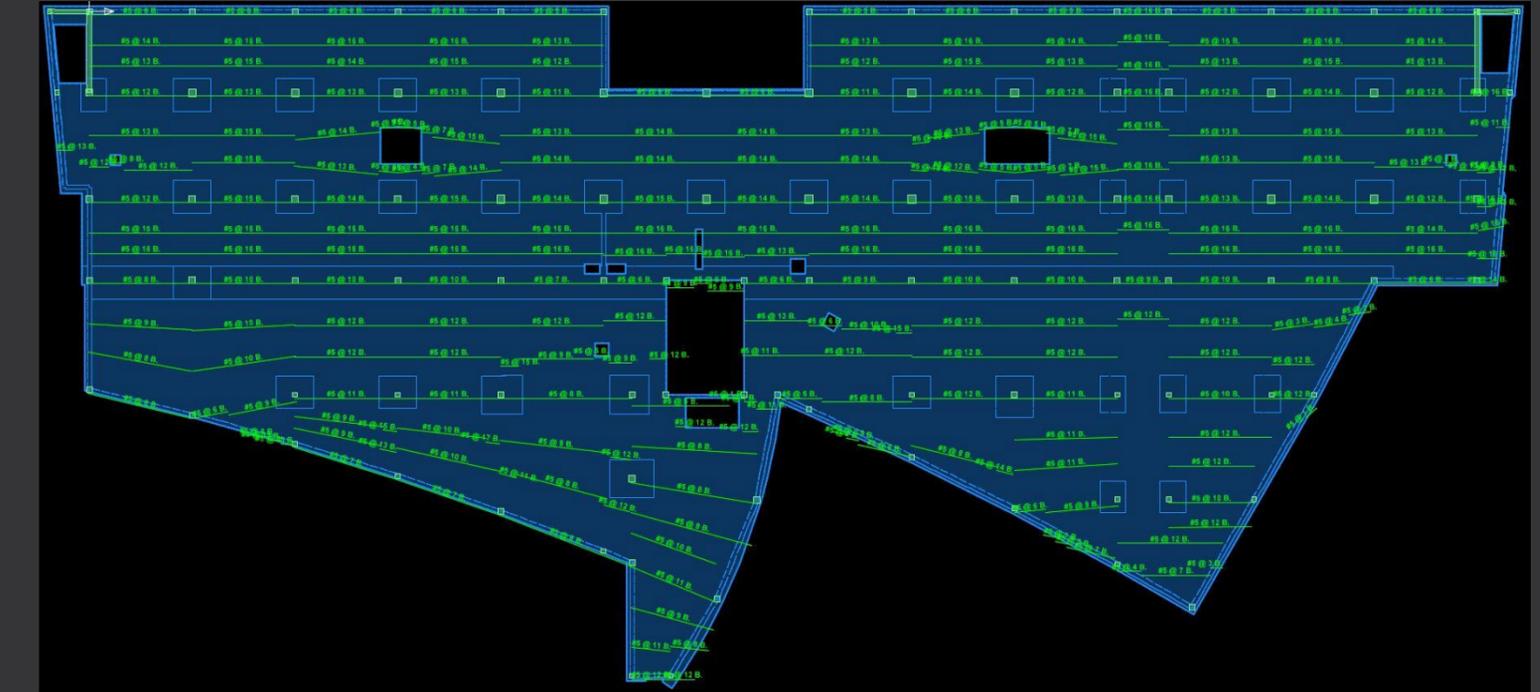
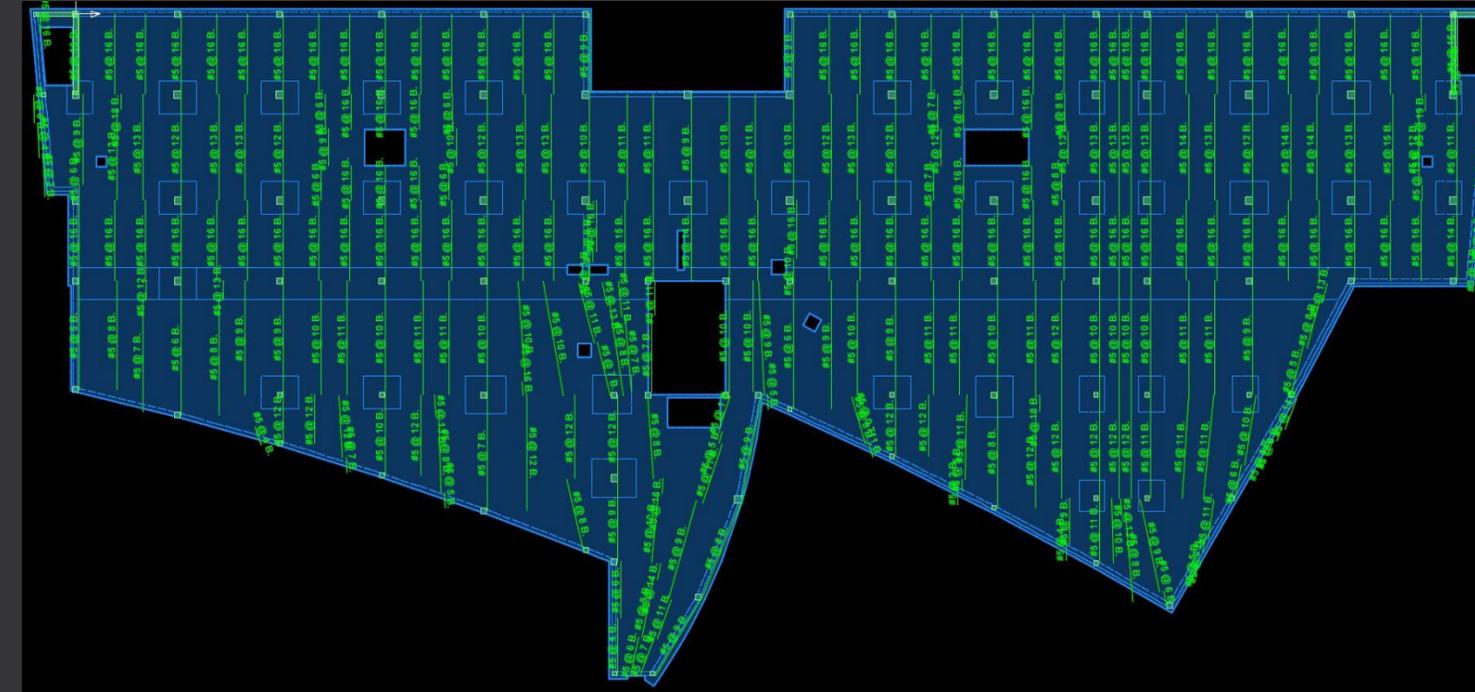
- 10 ½ in. Slab
- 14 in. Slab
- $l/6$ drop panel sizing
- Sized to lumber dimension



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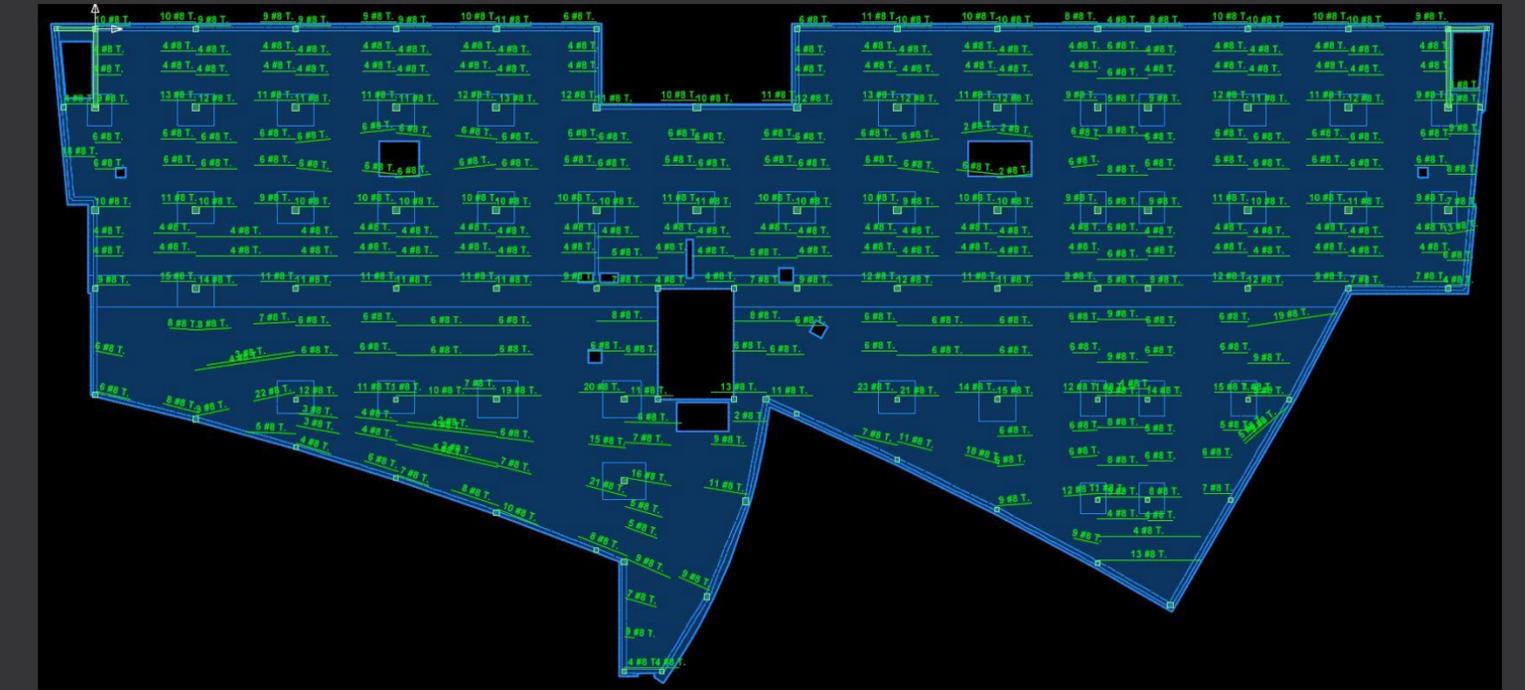
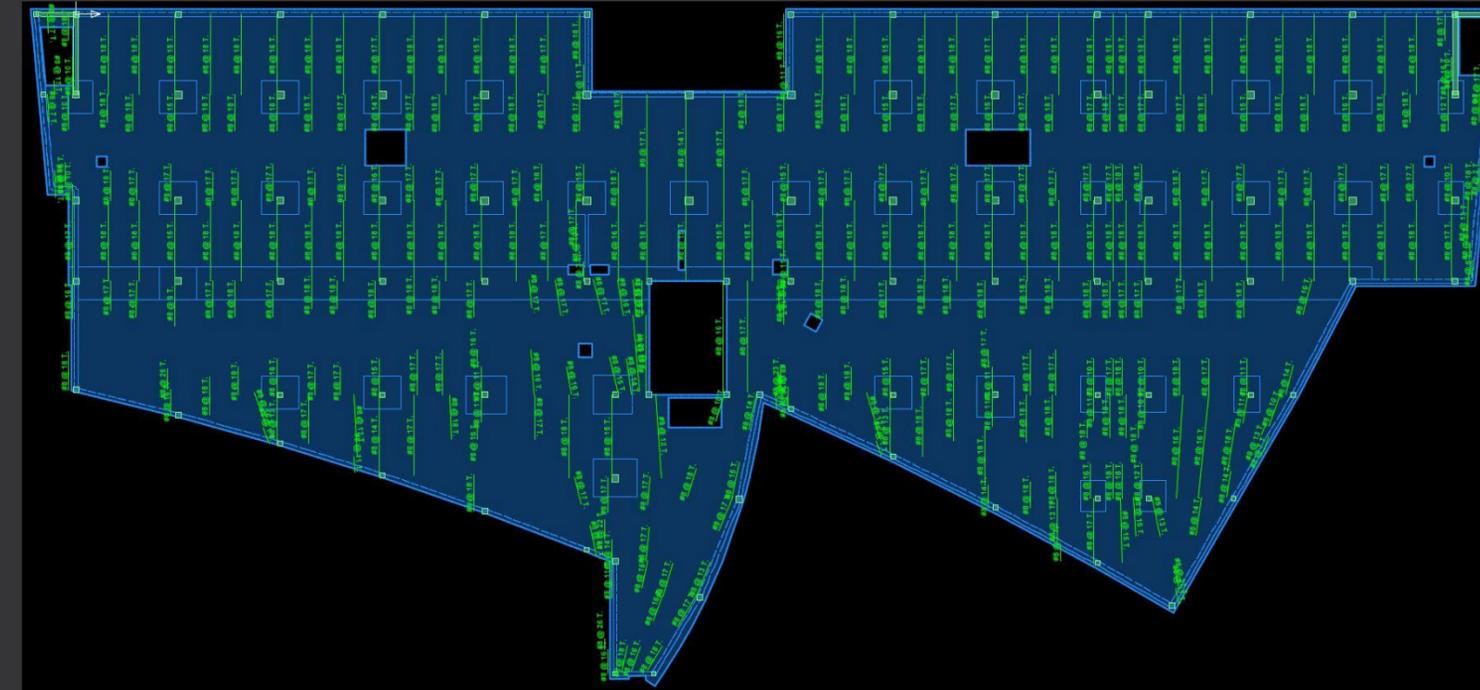
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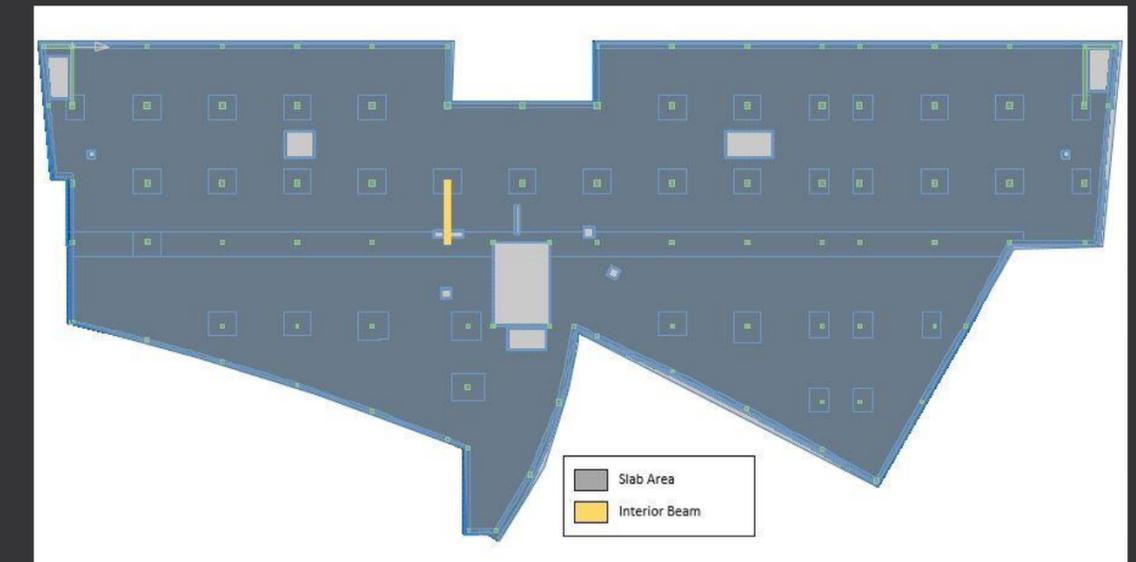
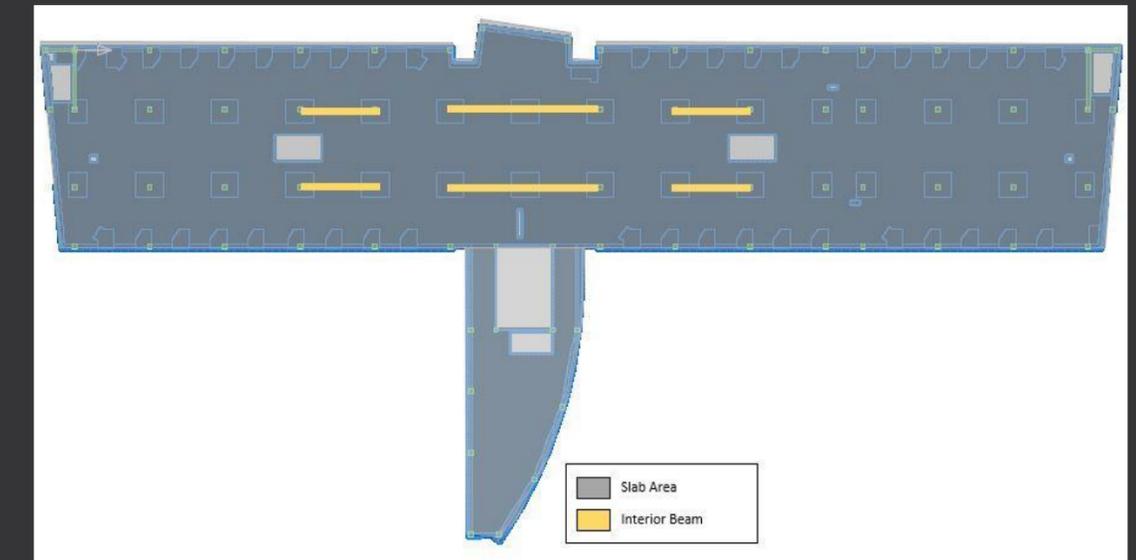
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- **Edge Beams**
 - 14"x26" Typ.

- **Transfer Beams**
 - 24"x26" Typ.



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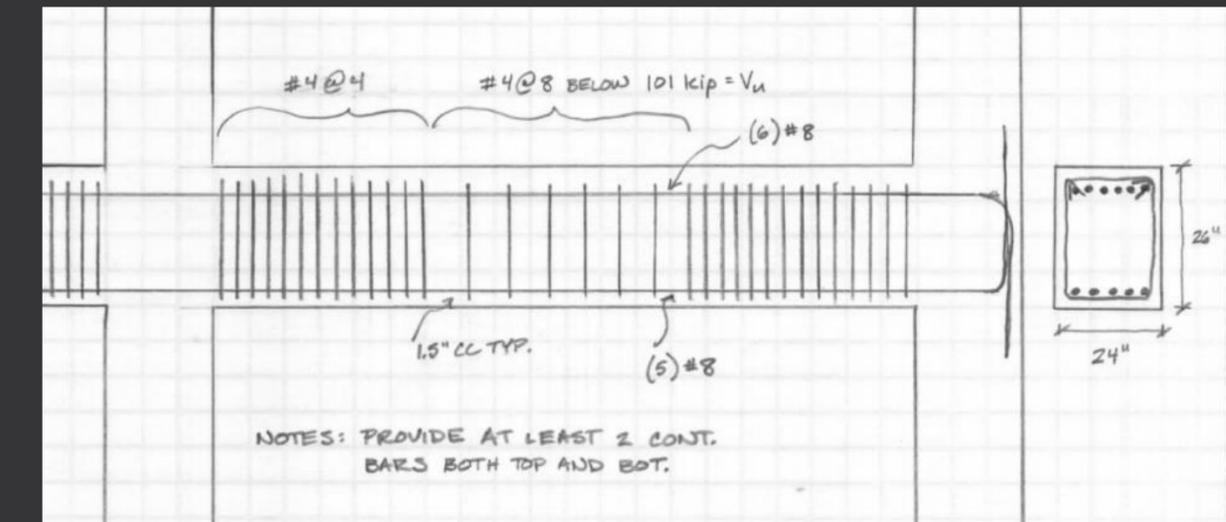
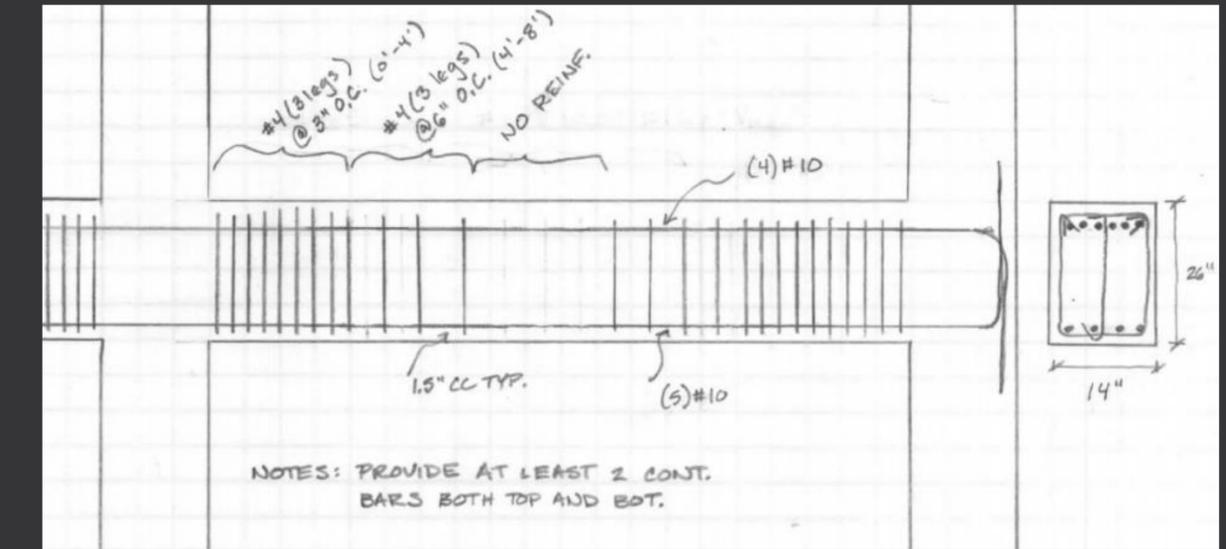
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• Edge Beams

- Torsion governed transverse reinf.
- $l/600$ for masonry deflections

• Transfer Beams

- Shear governed transverse reinf.



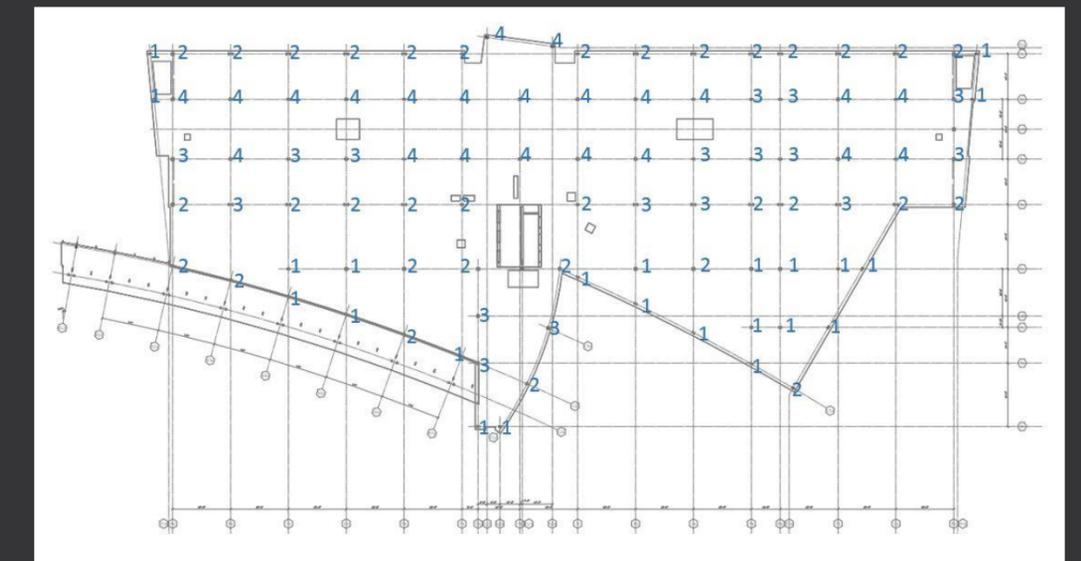
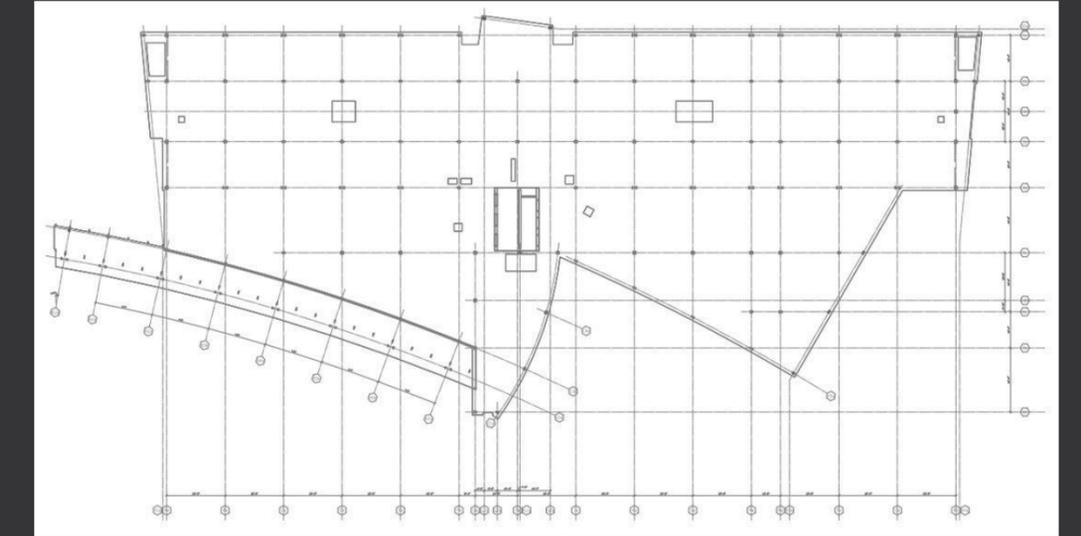
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- Column Design
 - Iterative process
 - 4 column sections
 - Max 4% long. reinf.

Column Type	Count (per floor)	Square Dimension (in)	Bars	As	ρ
1	23	16	(8) #10	10.16	0.0397
2	33	20	(12) #10	15.24	0.0381
3	18	24	(16) #10	20.32	0.0353
4	21	26	(16) #11	24.96	0.0369



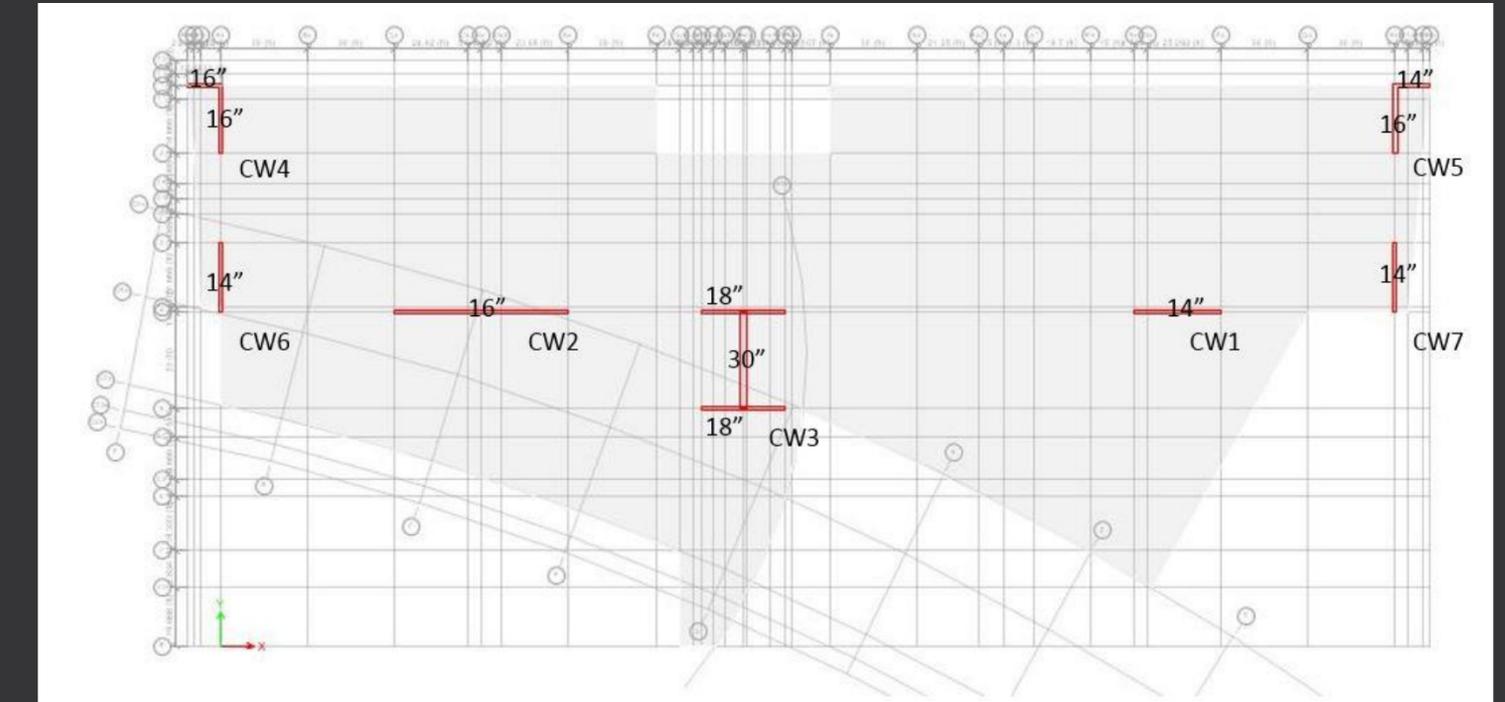
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Original LFRS Layout



Redesign LFRS Layout

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Seismic Base Shear Comparison

Story	Dia.	Wx (kips)	Hx (ft)	k	Hxk	Wx*Hxk	Cvx	Fx
First Floor	1	5076.9	16.0	1.23	30.7	155682.6	0.1	77.9
Second Floor	2	4987.5	32.0	1.23	72.2	359902.5	0.1	180.1
Third Floor	3	3417.4	46.0	1.23	113.0	385998.0	0.1	193.1
Fourth Floor	4	3417.4	60.0	1.23	156.8	535862.2	0.2	268.1
Fifth Floor	5	3147.4	74.0	1.23	203.1	639381.2	0.2	319.9
Roof	6	3141.9	88.0	1.23	251.6	790509.9	0.3	395.5
Penthouse Roof	7	640.0	106.0	1.23	316.6	202619.7	0.1	101.4
		23828.5						1434.6

Story	Dia.	Wx (kips)	Hx (ft)	k	Hxk	Wx*Hxk	Cvx	Fx
First Floor	1	11036.9	16	1.2	27.47409	303228.83	0.058659	196.8982
Second Floor	2	11124.85	30	1.2	58.23176	647819.57	0.125319	420.6542
Third Floor	3	7313.6	44	1.2	92.02926	673065.22	0.130202	437.0472
Fourth Floor	4	7313.6	58	1.2	128.0255	936327.24	0.18113	607.9933
Fifth Floor	5	7313.6	72	1.2	165.7724	1212393.3	0.234534	787.2537
Sixth Floor	6	6452.6	90	1.2	216.4312	1396543.7	0.270157	906.8296
Penthouse Roof	7	640	108	1.2	269.1172	172234.98	0.033318	111.8388
		51195.2						3356.68

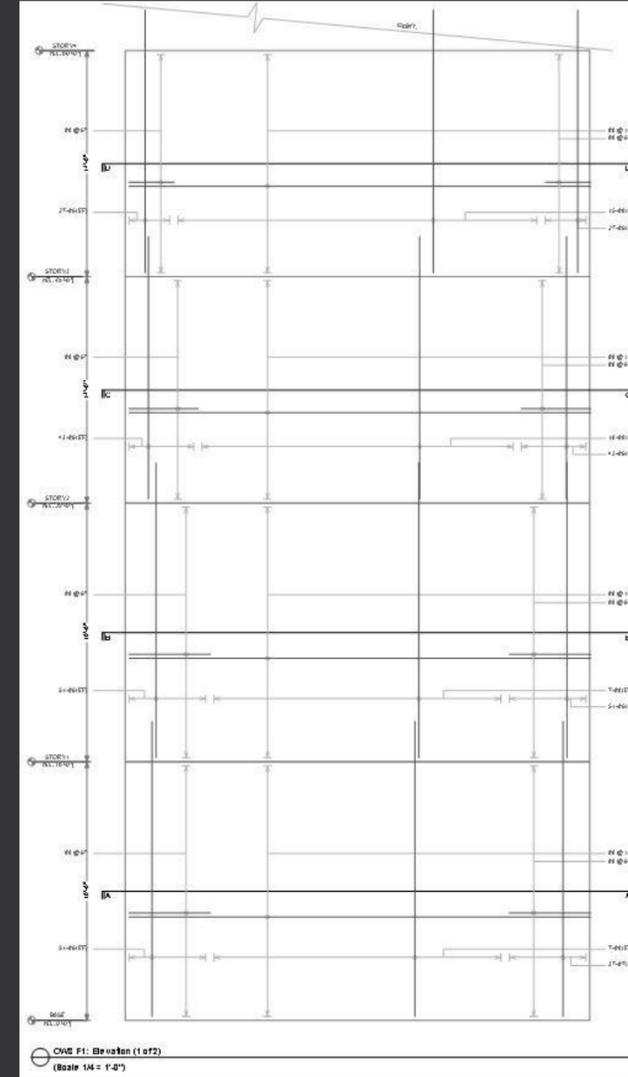
Modal Mass Participation (25 Modes)

Item	Static	Dynamic
	%	%
UX	99.94	94.46
UY	99.98	98.1
UZ	0	0

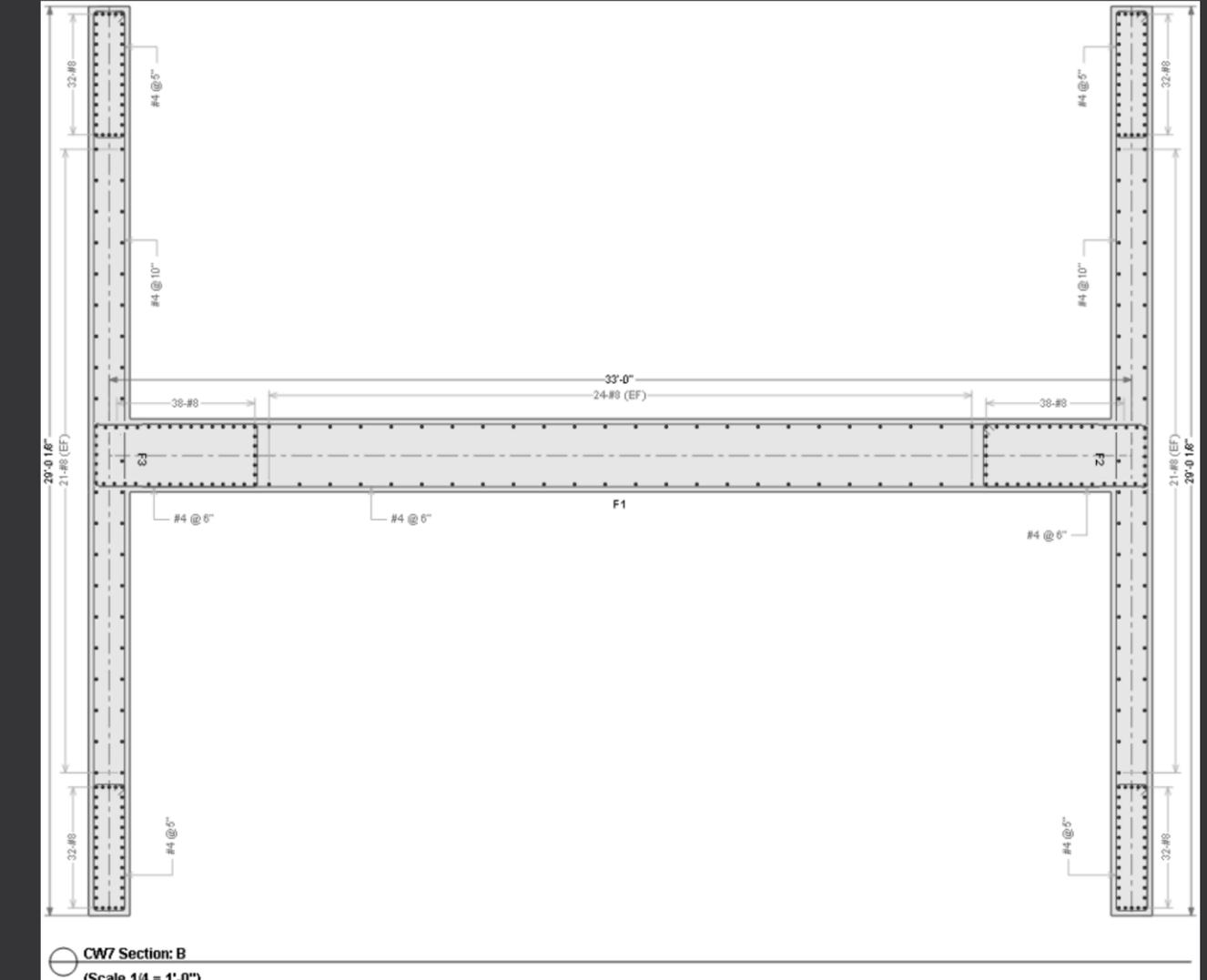
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CWS F1: Bevelton (1 of 2)
(Scale 1/4" = 1'-0")



CW7 Section: B
(Scale 1/4" = 1'-0")

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Construction Breadth: Cost and Schedule

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- **Construction Breadth: Cost and Schedule**
 - Weight
 - Cost
 - Schedule
- Landscape Architecture Breadth: Force Protection Design

Structural Weight Comparison

System	Weight	SF	lbs/sf
Composite Steel	23828.5	255760.1	93.2
Flat Slab Reinforced Concrete	51195.2	255760.1	200.2

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Reinforced Concrete Estimate

Code	Description	Cost
0311	Forms in Place	\$1,471,661.15
0315	Shores	\$665,732.79
0315	Expansion Joints	\$2,190.59
0321	Rebar Accessories	\$2,329,072.51
0331	Placing Concrete	\$1,652,434.17
Total Cost:		\$6,121,091.21

Composite Steel Estimate

Code	Description	Cost
140000	Vee-Jay Cement	\$2,339,075.00
190000	Hammert's Iron Works	\$8,784,148.00
980000	10% of Total Fee	\$324,348.90
Total Structure:		\$11,447,571.90
SF Ratio:		0.59
Total for Bed Tower:		\$6,808,911.94

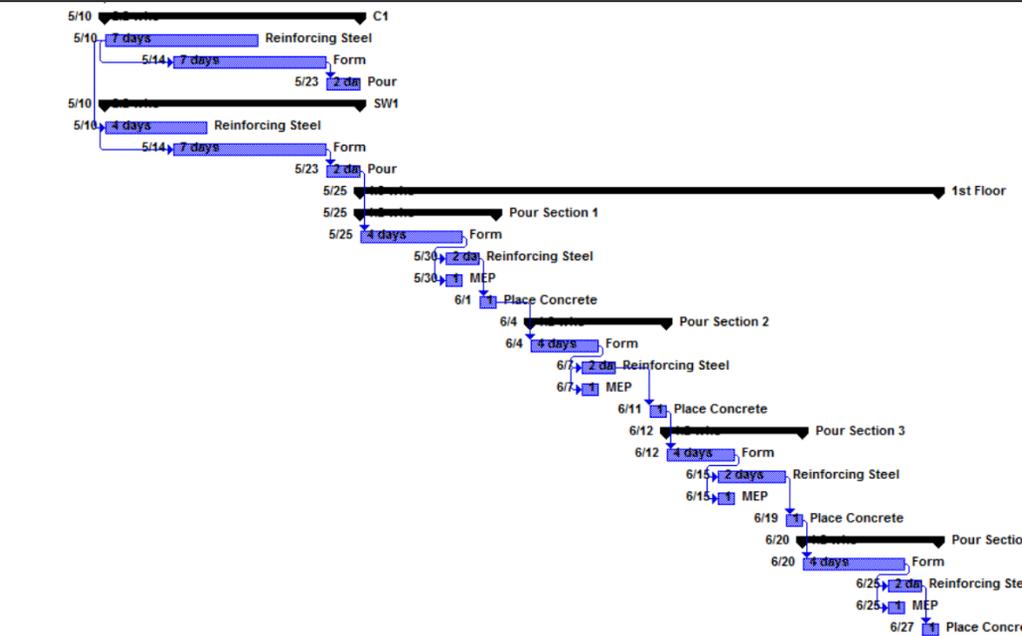
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- **Steel Structure:**
 - 377 days
- **Concrete Structure**
 - 381 days
 - Account for sufficient curing time
 - 4 pours per floor

▲ C1	2.2 wks	Thu 5/10/07	Thu 5/24/07
Reinforcing Steel	7 days	Thu 5/10/07	Fri 5/18/07
Form	7 days	Mon 5/14/07	Tue 5/22/07
Pour	2 days	Wed 5/23/07	Thu 5/24/07
▲ SW1	2.2 wks	Thu 5/10/07	Thu 5/24/07
Reinforcing Steel	4 days	Thu 5/10/07	Tue 5/15/07
Form	7 days	Mon 5/14/07	Tue 5/22/07
Pour	2 days	Wed 5/23/07	Thu 5/24/07
▲ 1st Floor	4.8 wks	Fri 5/25/07	Wed 6/27/07
▲ Pour Section 1	1.2 wks	Fri 5/25/07	Fri 6/1/07
Form	4 days	Fri 5/25/07	Wed 5/30/07
Reinforcing Steel	2 days	Wed 5/30/07	Thu 5/31/07
MEP	1 day	Wed 5/30/07	Wed 5/30/07
Place Concrete	1 day	Fri 6/1/07	Fri 6/1/07
▲ Pour Section 2	1.2 wks	Mon 6/4/07	Mon 6/11/07
Form	4 days	Mon 6/4/07	Thu 6/7/07
Reinforcing Steel	2 days	Thu 6/7/07	Fri 6/8/07
MEP	1 day	Thu 6/7/07	Thu 6/7/07
Place Concrete	1 day	Mon 6/11/07	Mon 6/11/07
▲ Pour Section 3	1.2 wks	Tue 6/12/07	Tue 6/19/07
Form	4 days	Tue 6/12/07	Fri 6/15/07
Reinforcing Steel	2 days	Fri 6/15/07	Mon 6/18/07
MEP	1 day	Fri 6/15/07	Fri 6/15/07
Place Concrete	1 day	Tue 6/19/07	Tue 6/19/07
▲ Pour Section 4	1.2 wks	Wed 6/20/07	Wed 6/27/07
Form	4 days	Wed 6/20/07	Mon 6/25/07
Reinforcing Steel	2 days	Mon 6/25/07	Tue 6/26/07
MEP	1 day	Mon 6/25/07	Mon 6/25/07
Place Concrete	1 day	Wed 6/27/07	Wed 6/27/07



Typical Schedule per floor of Reinforced Concrete Structure

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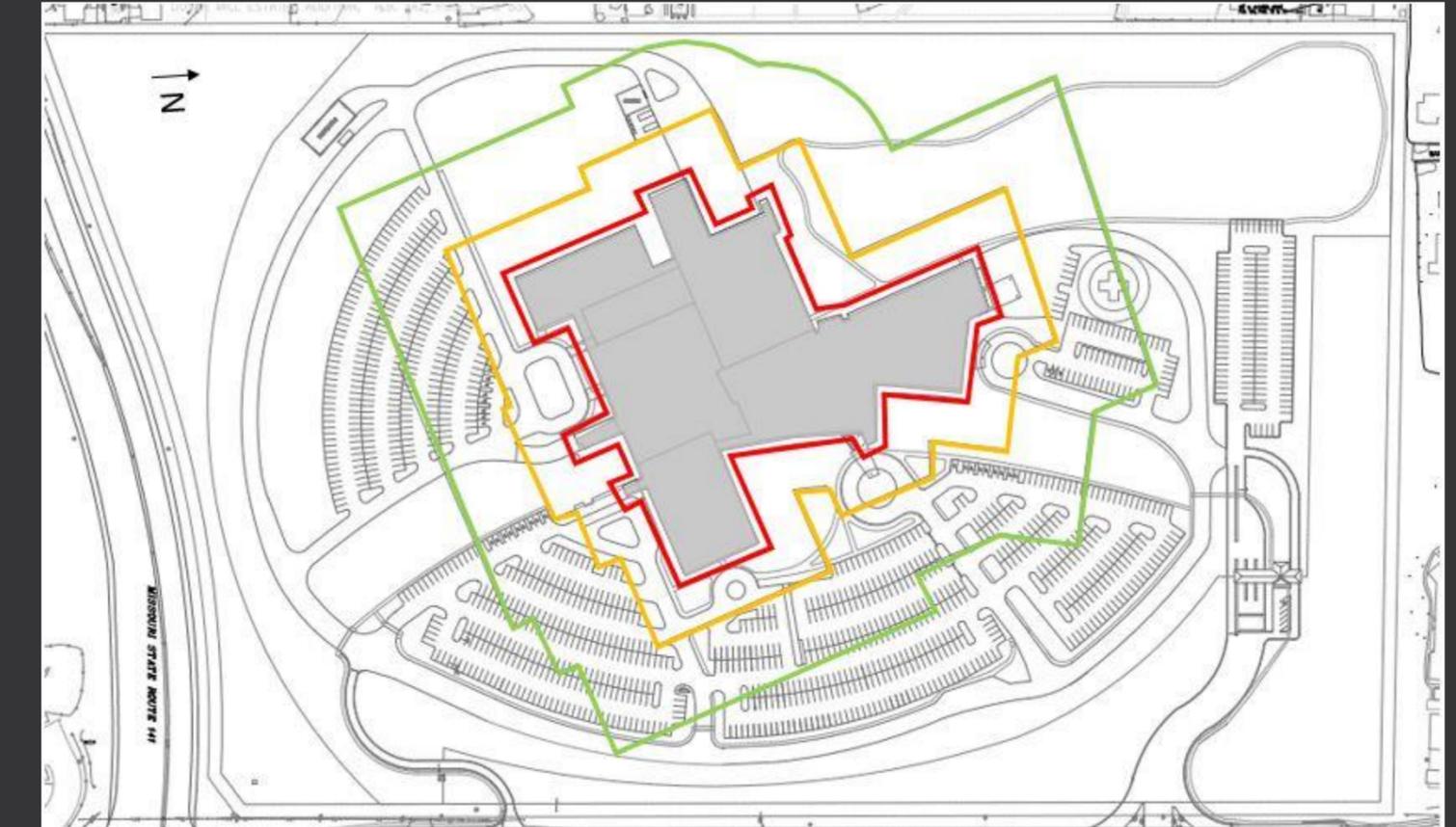
Landscape Architecture Breadth: Force Protection Design

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 - UFC Standoff Distances
 - Control Perimeter
 - Access Control Facilities
 - Uninterrupted Zone Landscaping
 - Design Validation
- Conclusion

- UFC 4-010-01
 - “DoD Minimum Antiterrorism Standards for Buildings”
- Goal
 - Minimize mass casualties
- Method
 - Identify probable threats
 - Provide safe standoff distances



Standard Standoffs for Billeting and Assembly Structures

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- **Standard Construction Standoff**
 - Min. 82 ft. Standoff
 - No parking
 - No trash Receptacles
- **Unobstructed Zone**
 - No foliage below 3'
 - No partial enclosures



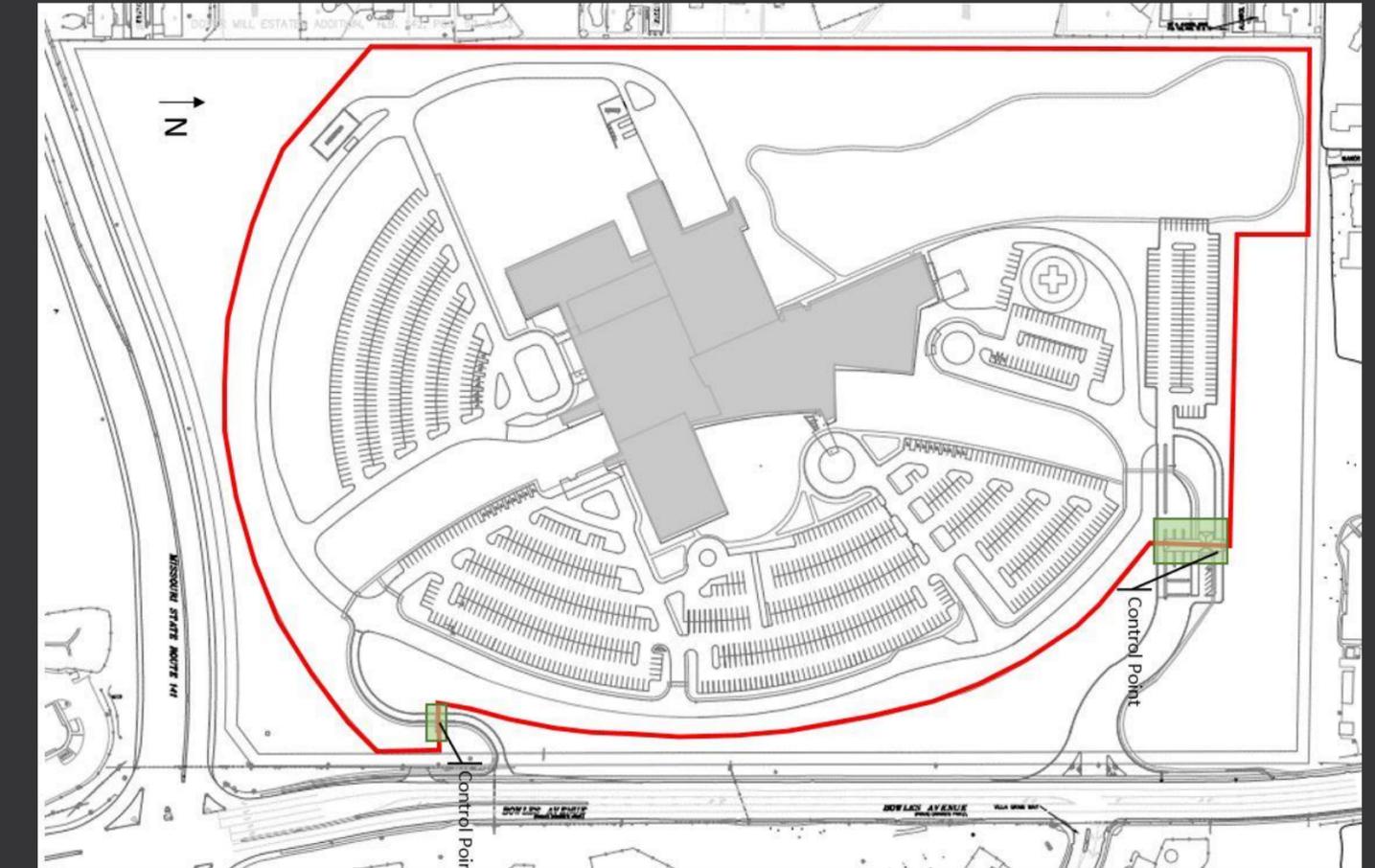
Non-Compliant Site Features

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- **Control Perimeter**
 - Min. 207' Standoff
- **Access Control Facilities**



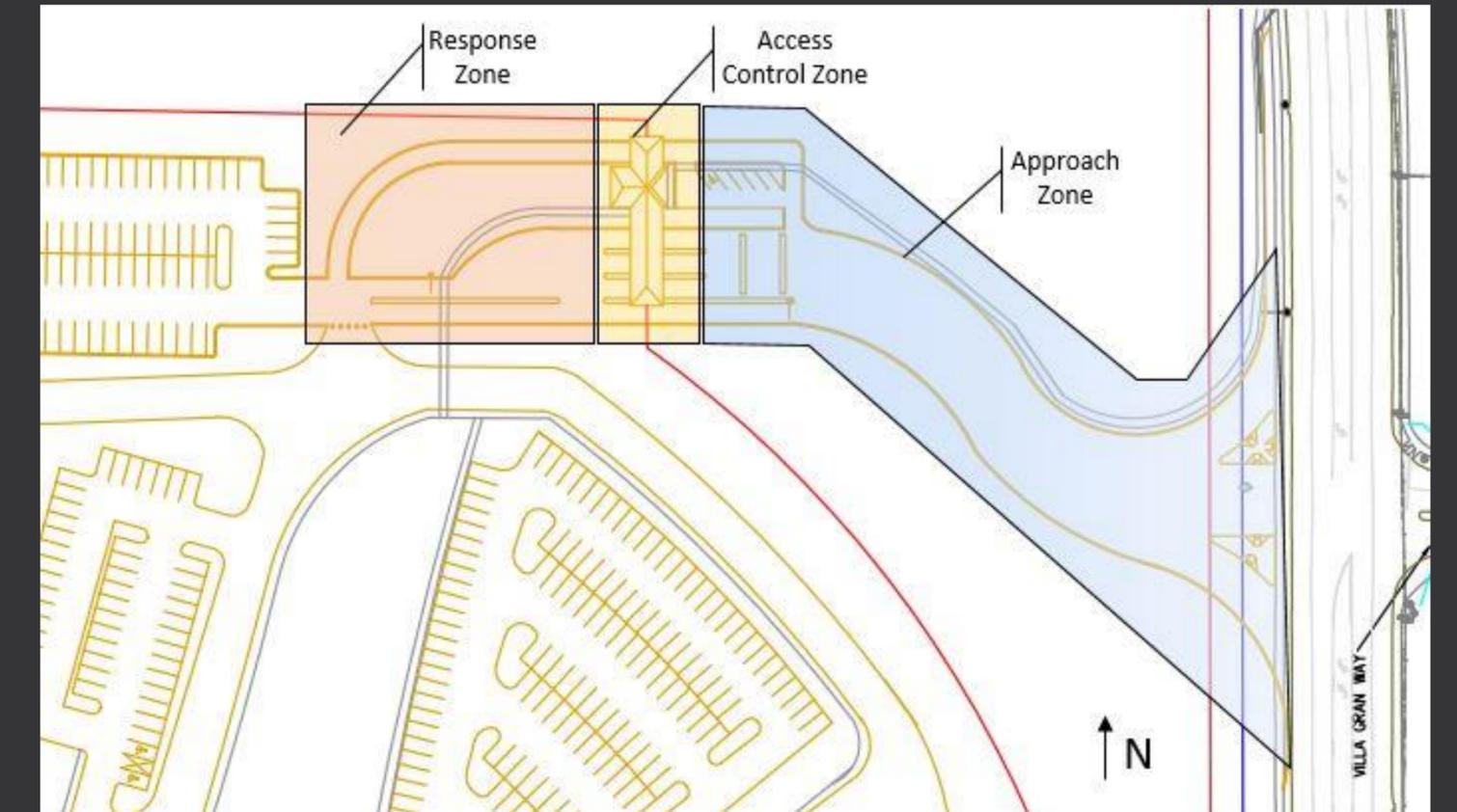
Control Perimeter and Access Control
Facilities

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- **Access Control Facilities (UFC 4-022-01)**
 - Approach Zone
 - Access Control Zone
 - Response Zone
- **Final Denial Barrier**



Non-Compliant Site Features

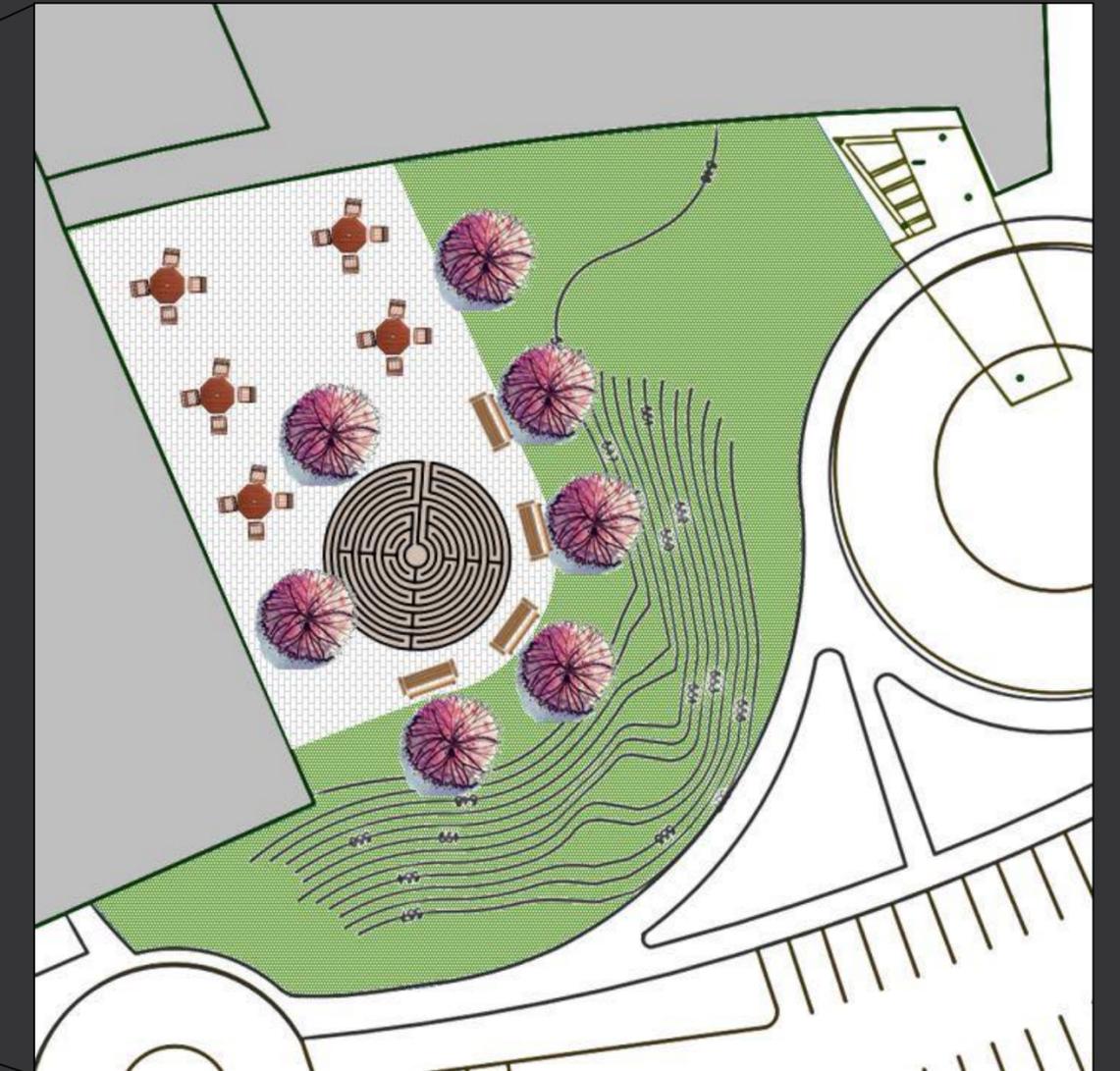
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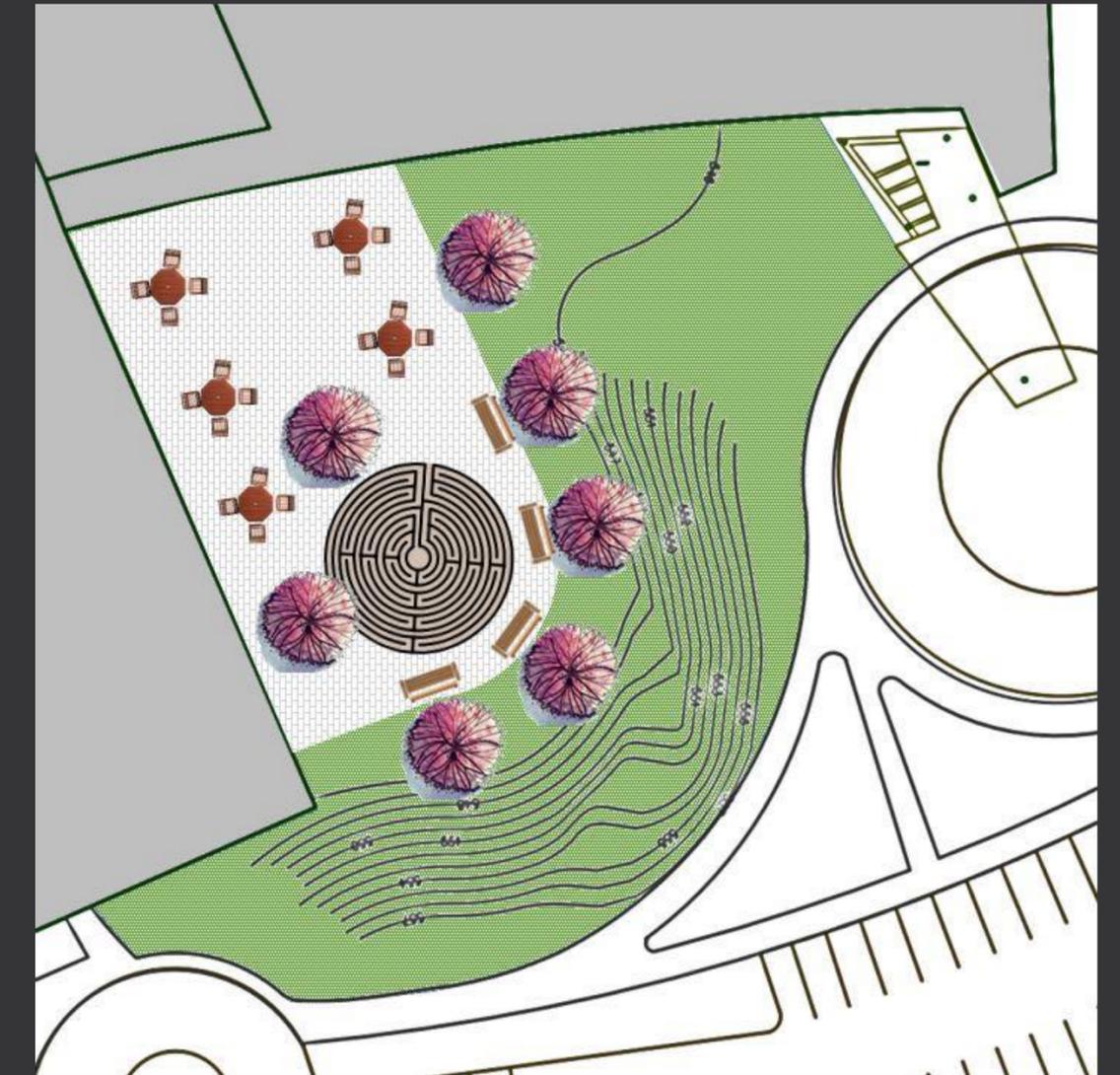
Micro-Design of "Unobstructed Zone" Garden



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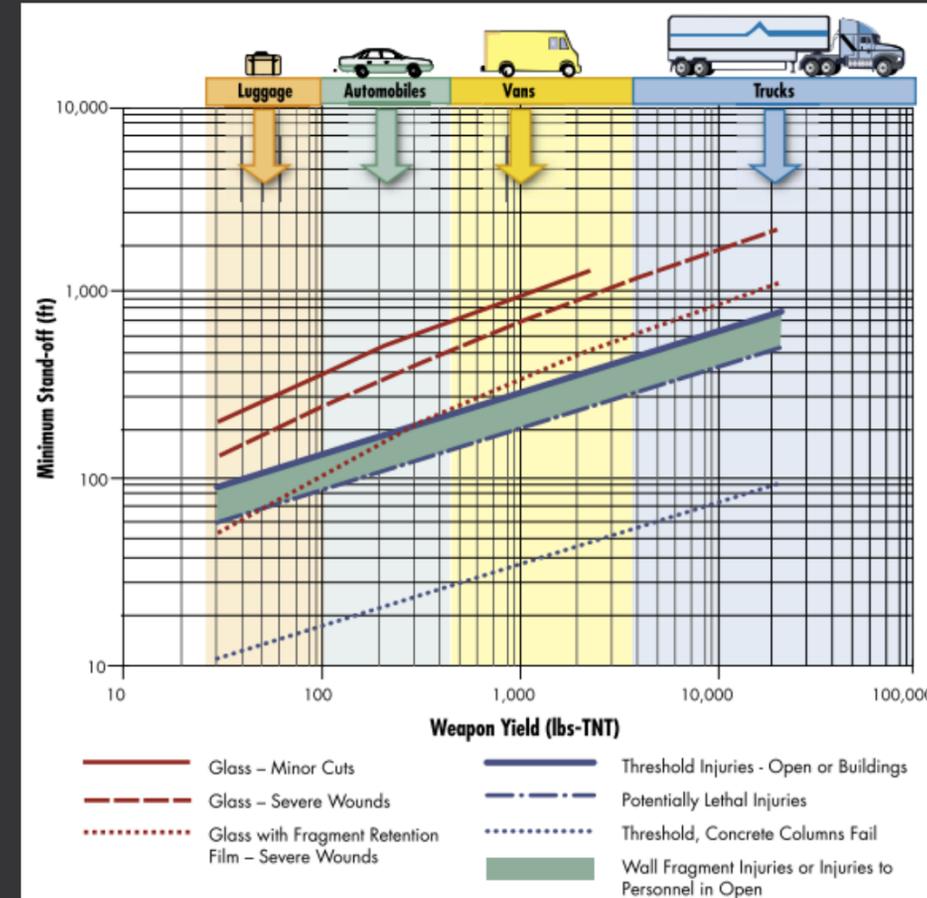
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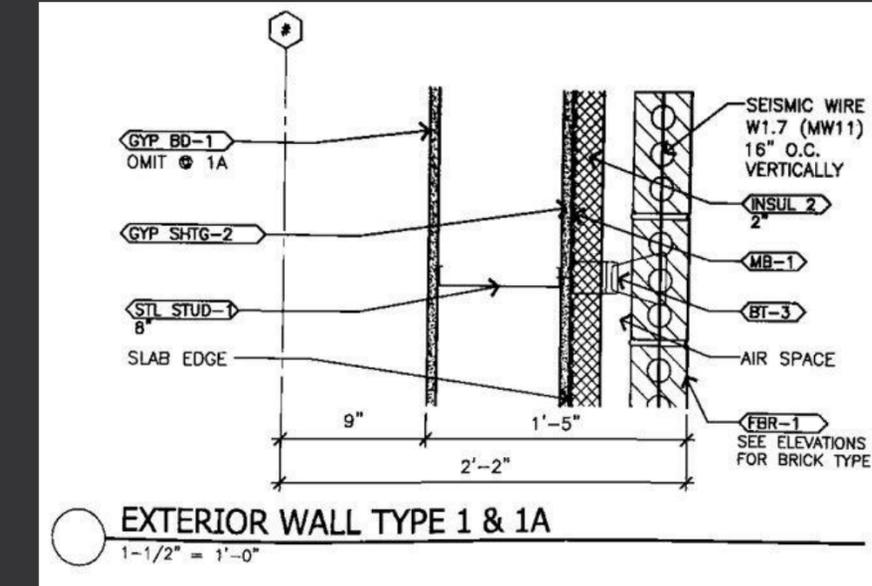
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Typical Charge Weight – Standoff Diagram



Typical Exterior Wall Section

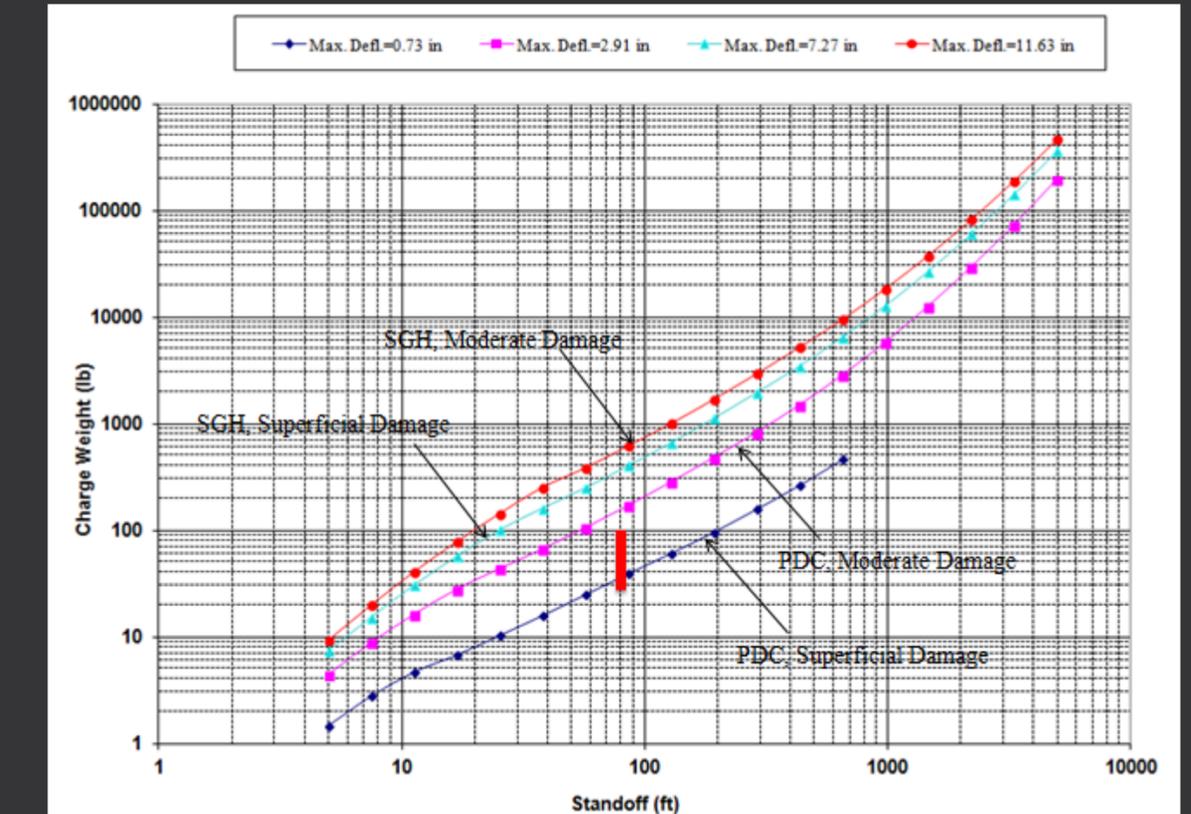
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	Δ_{max} inch	μ_{max}	θ_{max} degree
PDC	-	0.5	-
SGH	H/30 = 6.4	5	7
Theoretical	-1.9	1.31	-1.1

Blast Response Criteria Comparison



SBEDS Generated Charge-Weight – Standoff Diagram

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- **Structural Depth**
 - Feasible Design
- **Construction Breadth**
 - Feasible Design
 - Save \$687,820.00
 - Comparable schedule to within 4 days
- **Landscape Architecture Breadth**
 - Feasible Design
 - Provides moderate level of protection
 - Meets UFC design criteria

Feasible Design

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Questions

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- [Dead and Live Loads](#)
- [Wind Loads](#)
- [Seismic Loads](#)
- [Slab Concept Output](#)
- [Edge Beam Deflections](#)
- [Lateral Assumptions](#)
- [Lateral Drifts](#)
- [Construction Estimate](#)
- [Site Design](#)
- [Standoff Tables](#)
- [Blast Response Criteria](#)
- [SBEDS Output](#)

Questions

Live Load	Value (psf)	Code Minimum (psf)
Operating Room	60	60
Offices	50	50
Private Rooms	40	40
Corridors (1st Floor)	100	100
Corridors (other)	80	80
Stairs and Exits	100	100
Equipment Rooms	125	125

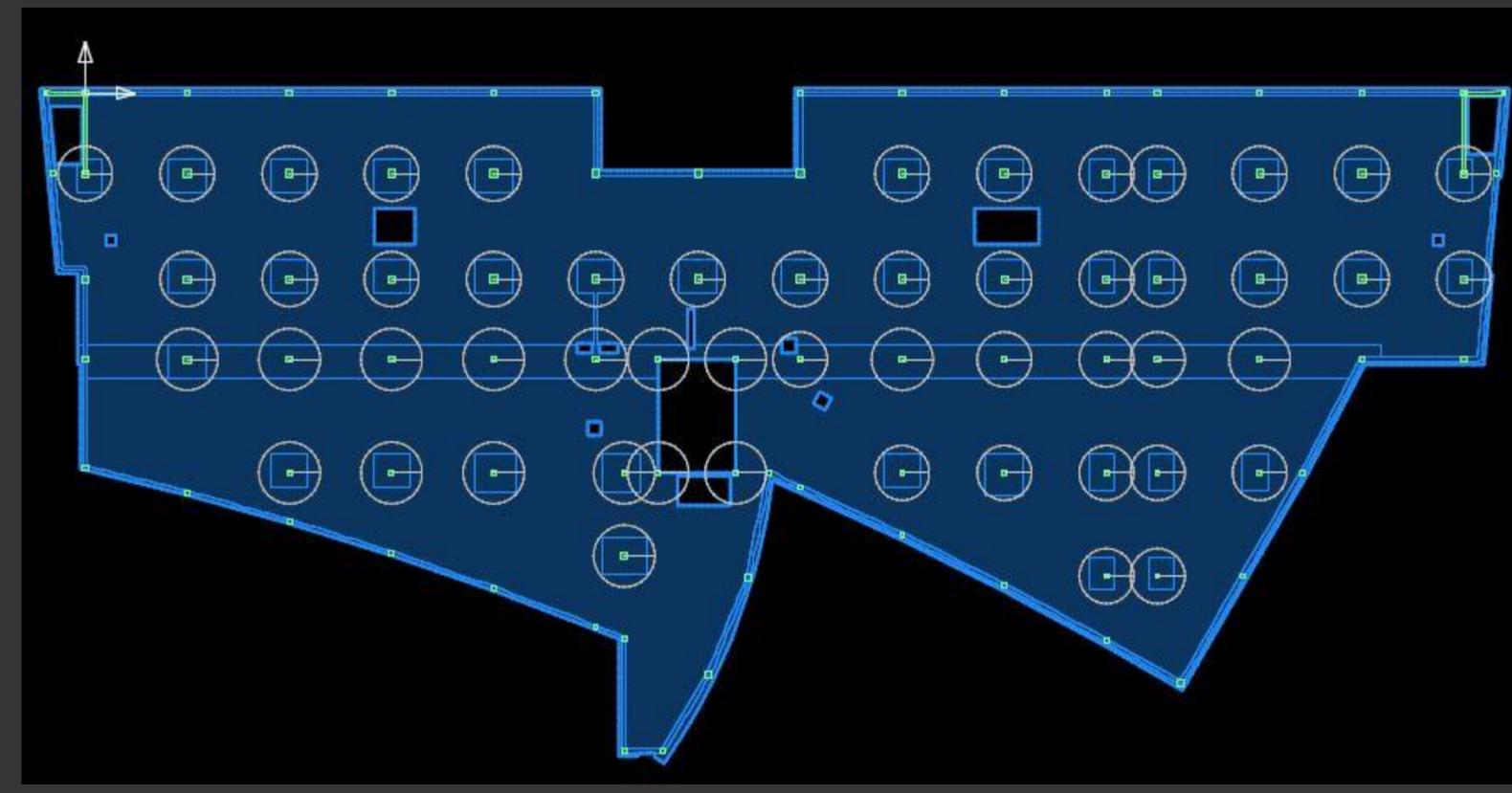
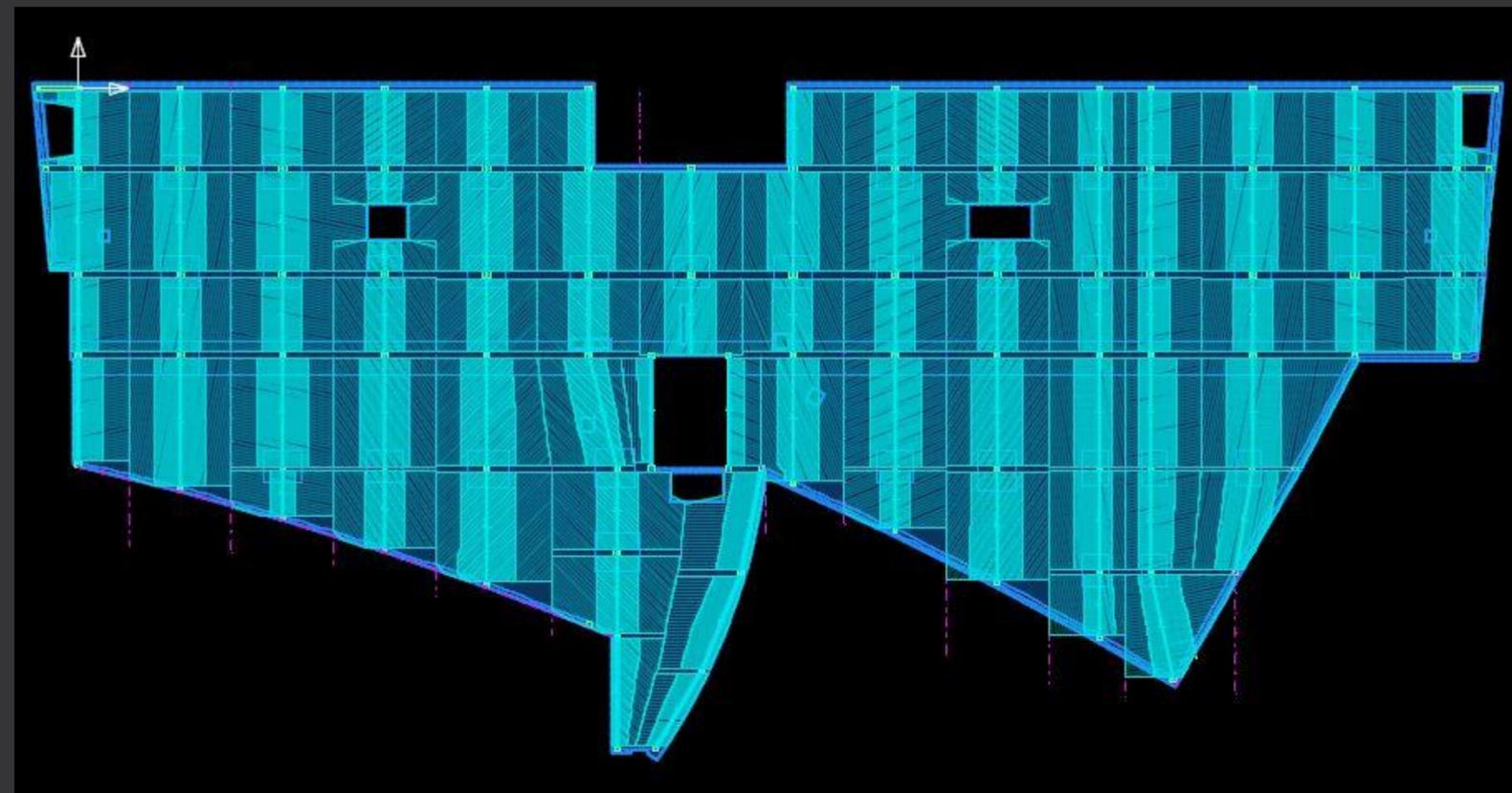
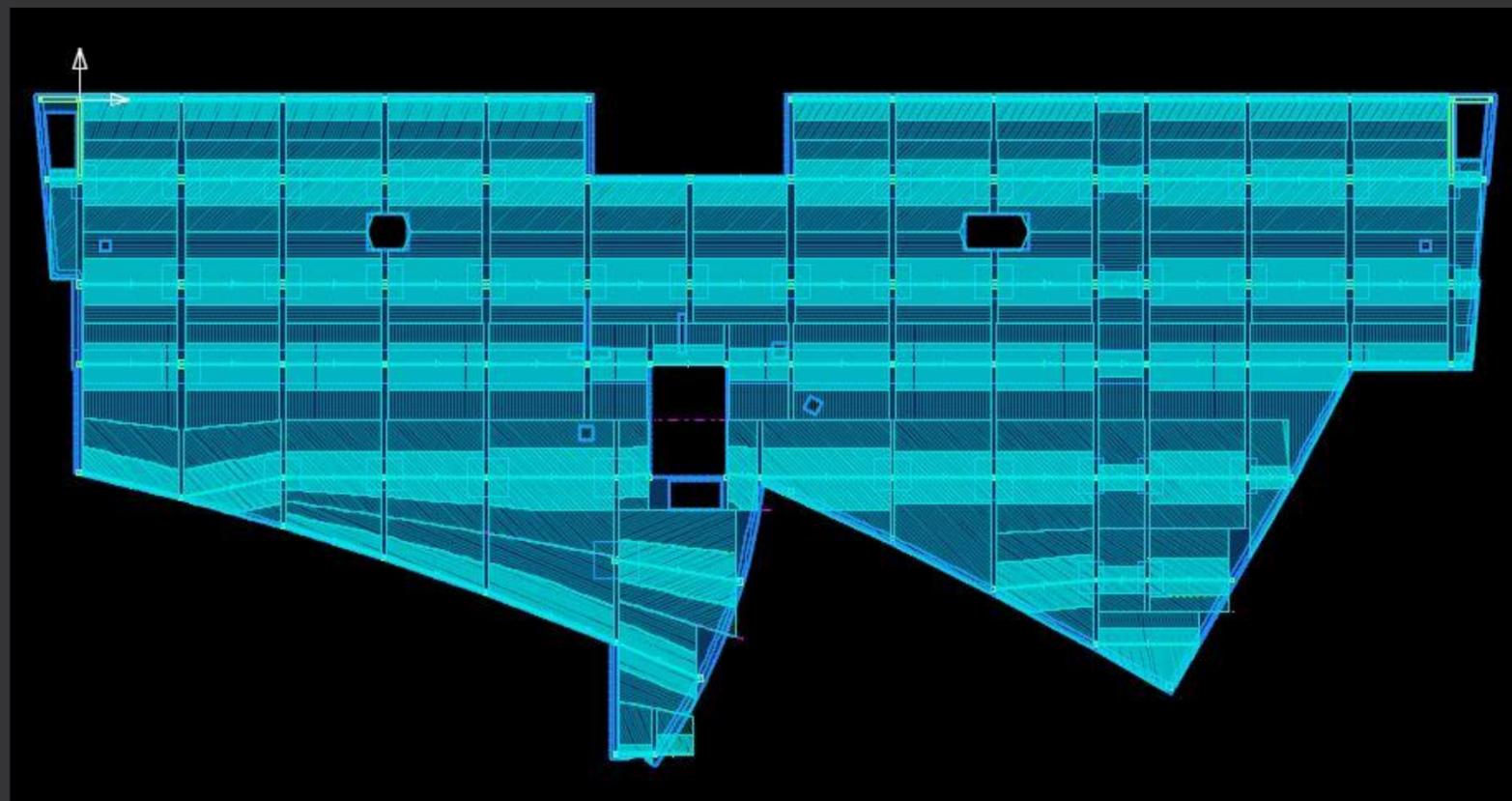
Dead Load	Original Values (psf)	Calculated Values (psf)
Hospital Floor	60	64
Hospital Roof	78	70

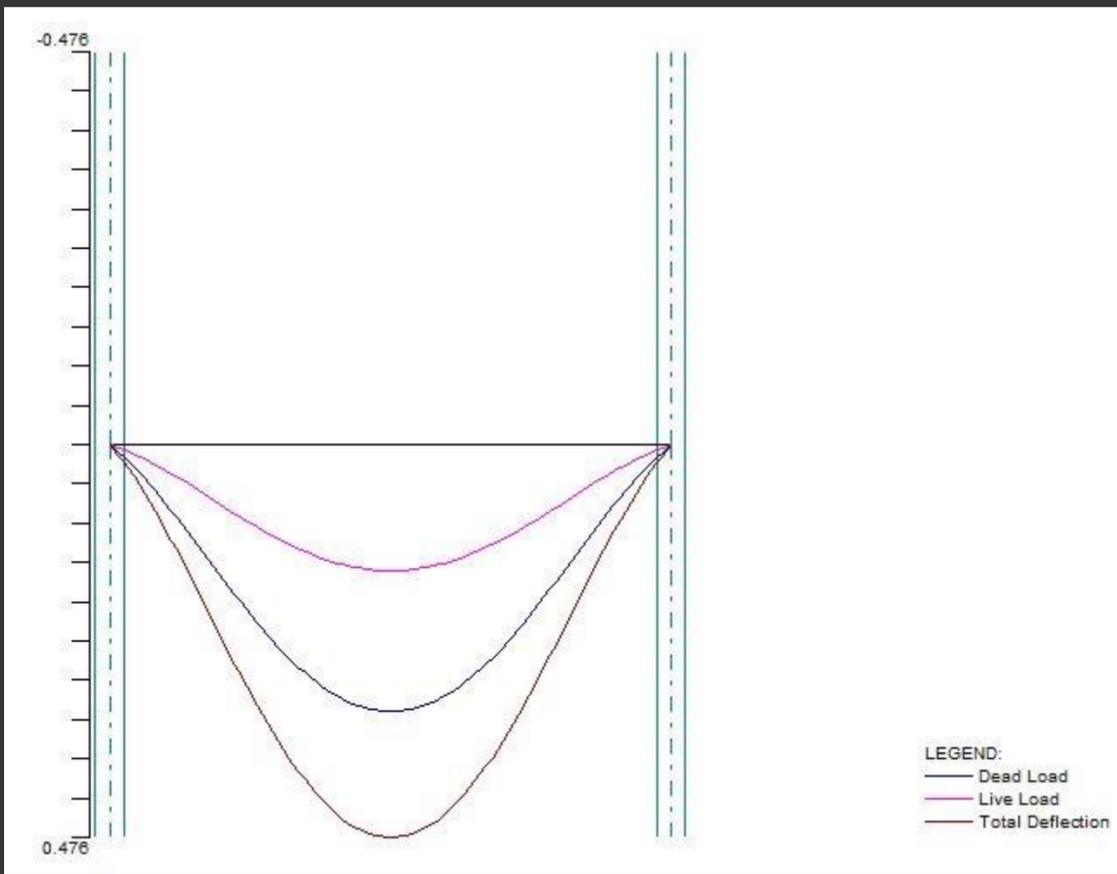
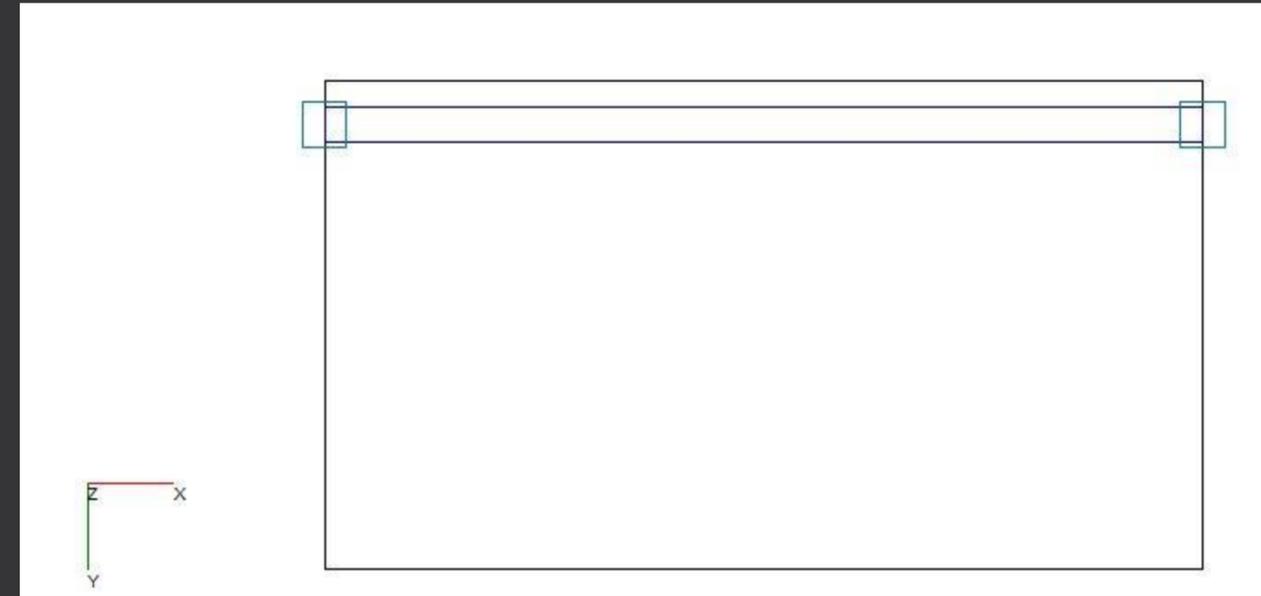
Index	Combinations
1	1.4D
2	1.2D + 1.6L + 0.5(L _r or S or R)
3	1.2D + 1.6(L _r or S or R) + (L or 0.5W)
4	1.2D + 1.0W + L + 0.5(L _r or S or R)
5	1.2D + 1.0E + L + 0.2S
6	0.9D + 1.0W
7	0.9D + 1.0E

Parameter	Symbol	Value
Occupancy Category	-	IV
Basic Wind Speed	V	115 mph
Exposure Category	-	B
Wind Directionality Factor	Kd	0.85
Importance Factor	Ie	1.5
Topographical Factor	Kzt	1
Gust Effect Factor	G	0.8205
Enclosure Classification	-	Enclosed

ARM			External Pressure			Internal Pressure				Total Pressure (kip)
Location	z (ft)	Story Height (ft)	qzGCp (psf)	Tributary Width (ft)	External Pressure (kip)	Gcpi	qhGCpi (psf)	Tributary Width	Internal Pressure (kip)	
Windward	-16	16.0	11.0	0.0	0.0	0.18	5.0	0.0	0.0	0.0
	0	16.0	11.0	42.3	0.0	0.18	5.0	0.0	0.0	0.0
	16	14.0	11.2	42.3	7.1	0.18	5.0	0.0	0.0	7.1
	30	14.0	13.4	42.3	7.9	0.18	5.0	0.0	0.0	7.9
	44	14.0	14.9	42.3	8.8	0.18	5.0	0.0	0.0	8.8
	58	14.0	16.1	42.3	9.5	0.18	5.0	0.0	0.0	9.5
	72	18.8	17.2	42.3	11.9	0.18	5.0	0.0	0.0	11.9
	90.75	0.0	18.3	42.3	7.3	0.18	5.0	0.0	0.0	7.3
Leeward	90.75	90.8	-11.5	42.3	43.9	0.18	5.0	0.0	0.0	43.9
Parapet WW	93	2.2	34.6	42.3	3.2	1.5	41.5	0.0	0.0	3.2
Parapet LW	93	2.2	23.1	42.3	2.1	-1	-27.7	0.0	0.0	2.1
TOWER			External Pressure			Internal Pressure				Total Pressure (kip)
Location	z (ft)	Story Height (ft)	qzGCp (psf)	Tributary Width (ft)	External Pressure (kip)	Gcpi	qhGCpi (psf)	Tributary Width	Internal Pressure (kip)	
Windward	-16	16.0	11.4	0.0	0.0	0.18	5.0	0.0	0.0	0.0
	0	16.0	11.4	224.8	0.0	0.18	5.0	0.0	0.0	0.0
	16	14.0	11.6	224.8	39.0	0.18	5.0	150.0	11.2	50.2
	30	14.0	13.9	374.8	72.7	0.18	5.0	0.0	0.0	72.7
	44	14.0	15.5	374.8	81.1	0.18	5.0	0.0	0.0	81.1
	58	14.0	16.7	374.8	87.7	0.18	5.0	0.0	0.0	87.7
	72	18.8	17.8	374.8	109.1	0.18	5.0	0.0	0.0	109.1
	90.75	0.0	19.0	71.0	12.6	0.18	5.0	0.0	0.0	12.6
Leeward	90.75	90.8	-4.8	374.8	161.6	0.18	5.0	0.0	0.0	161.6
Parapet WW	93	2.2	41.5	374.8	33.7	1.5	41.5	0.0	0.0	33.7
Parapet LW	93	2.2	27.7	374.8	22.5	-1	-27.7	0.0	0.0	374.8
Base Shear:										1085.2

ARM			External Pressure			Internal Pressure				Total Pressure (kip)
Location	z (ft)	Story Height (ft)	qzGCp (psf)	Tributary Width (ft)	External Pressure (kip)	Gcpi	qhGCpi (psf)	Tributary Width	Internal Pressure (kip)	
Windward	-16	16.0	11.7	0.0	0.0	0.18	5.0	0.0	0.0	0.0
	0	16.0	11.7	113.8	0.0	0.18	5.0	0.0	0.0	0.0
	16	14.0	11.9	113.8	20.3	0.18	5.0	0.0	0.0	20.3
	30	14.0	14.2	113.8	22.6	0.18	5.0	0.0	0.0	22.6
	44	14.0	15.8	113.8	25.2	0.18	5.0	0.0	0.0	25.2
	58	14.0	17.1	113.8	27.3	0.18	5.0	0.0	0.0	27.3
	72	18.8	18.2	113.8	34.0	0.18	5.0	0.0	0.0	34.0
	90.75	0.0	19.5	67.0	12.2	0.18	5.0	0.0	0.0	12.2
Leeward	90.75	90.8	-7.3	113.8	75.4	0.18	5.0	0.0	0.0	75.4
Parapet WW	93	2.2	0.0	113.8	0.0	1.5	41.5	0.0	0.0	0.0
Parapet LW	93	2.2	0.0	113.8	0.0	-1	-27.7	0.0	0.0	0.0
TOWER			External Pressure			Internal Pressure				Total Pressure (kip)
Location	z (ft)	Story Height (ft)	qzGCp (psf)	Tributary Width (ft)	External Pressure (kip)	Gcpi	qhGCpi (psf)	Tributary Width	Internal Pressure (kip)	
Windward	-16	16.0	10.5	0.0	0.0	0.18	5.0	0.0	0.0	0.0
	0	16.0	10.5	0.0	0.0	0.18	5.0	0.0	0.0	0.0
	16	14.0	10.7	0.0	0.0	0.18	5.0	77.3	5.8	5.8
	30	14.0	12.7	77.3	13.8	0.18	5.0	0.0	0.0	13.8
	44	14.0	14.2	77.3	15.4	0.18	5.0	0.0	0.0	15.4
	58	14.0	15.4	77.3	16.7	0.18	5.0	0.0	0.0	16.7
	72	18.8	16.4	77.3	20.7	0.18	5.0	0.0	0.0	20.7
	90.75	0.0	17.5	31.0	5.1	0.18	5.0	0.0	0.0	5.1
Leeward	90.75	90.8	-10.9	77.3	76.7	0.18	5.0	0.0	0.0	76.7
Parapet WW	93	2.2	33.0	77.3	5.5	1.5	41.5	0.0	0.0	5.5
Parapet LW	93	2.2	22.0	77.3	3.7	-1	-27.7	0.0	0.0	77.33
Base Shear:										454.1

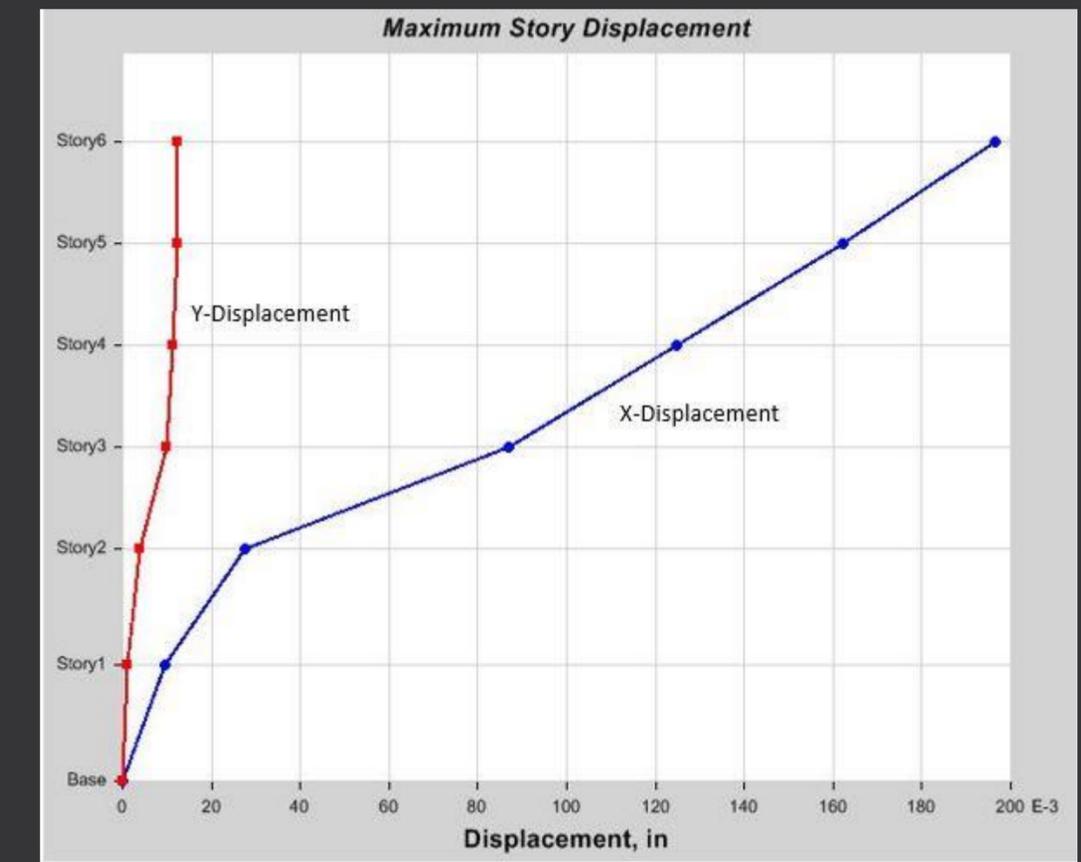
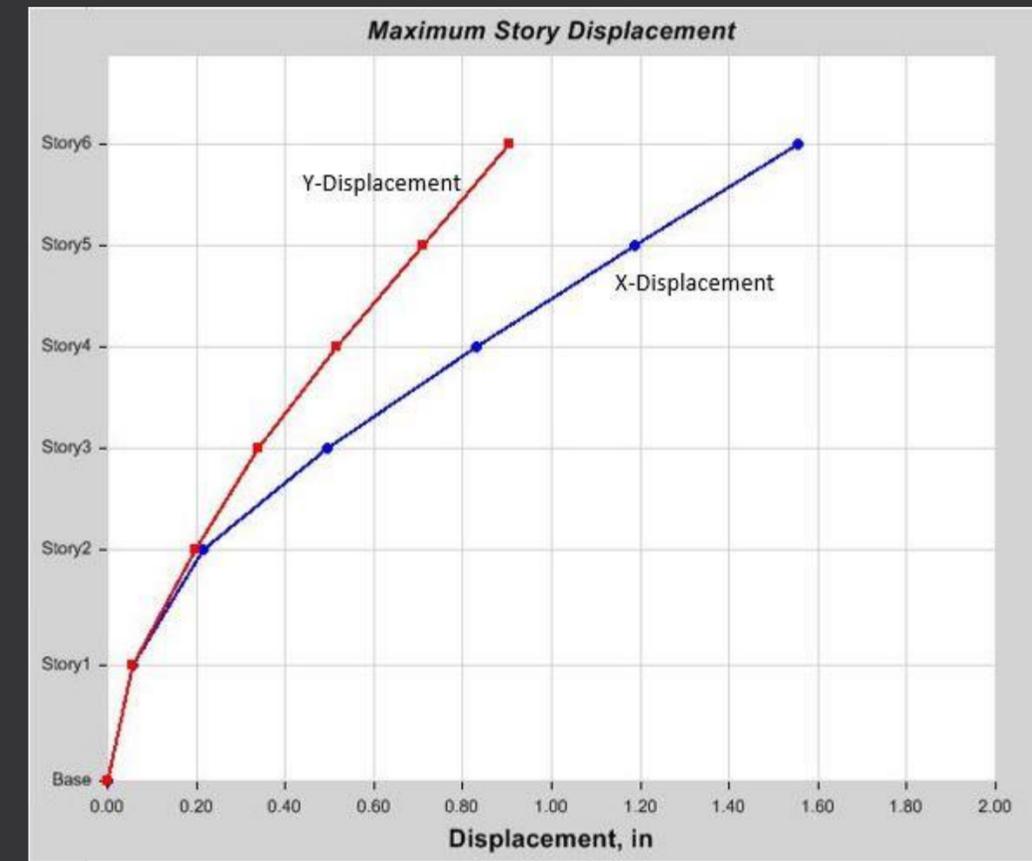
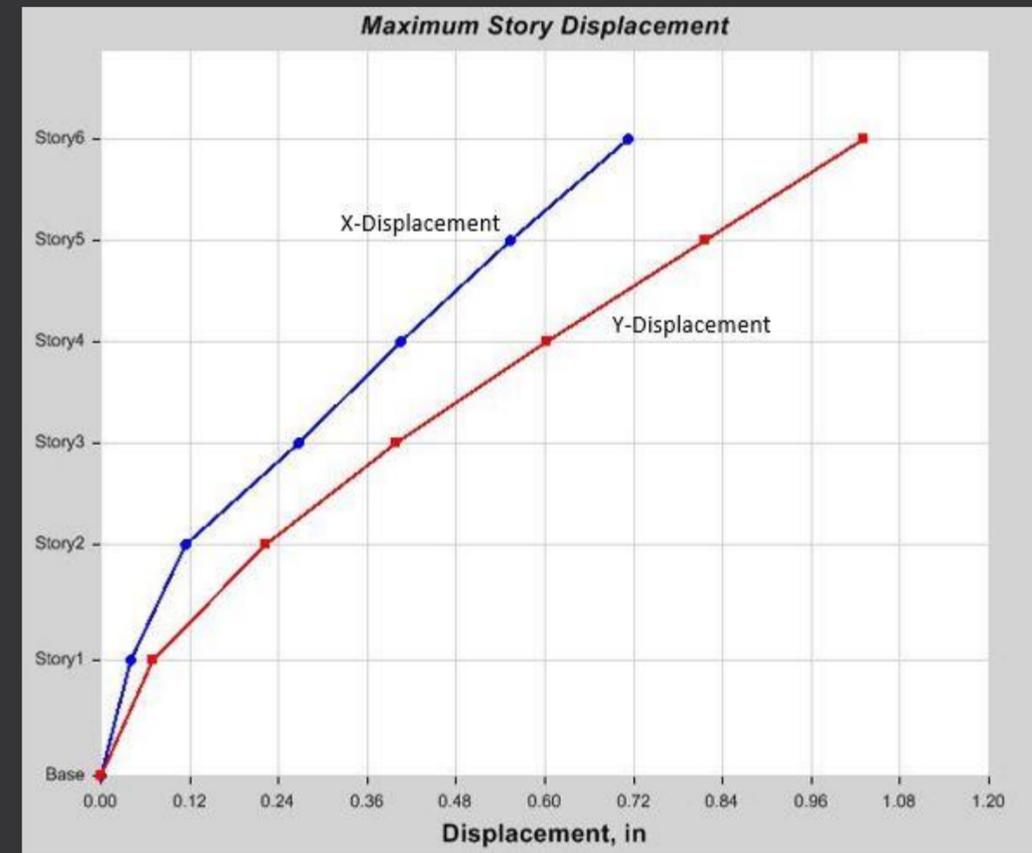


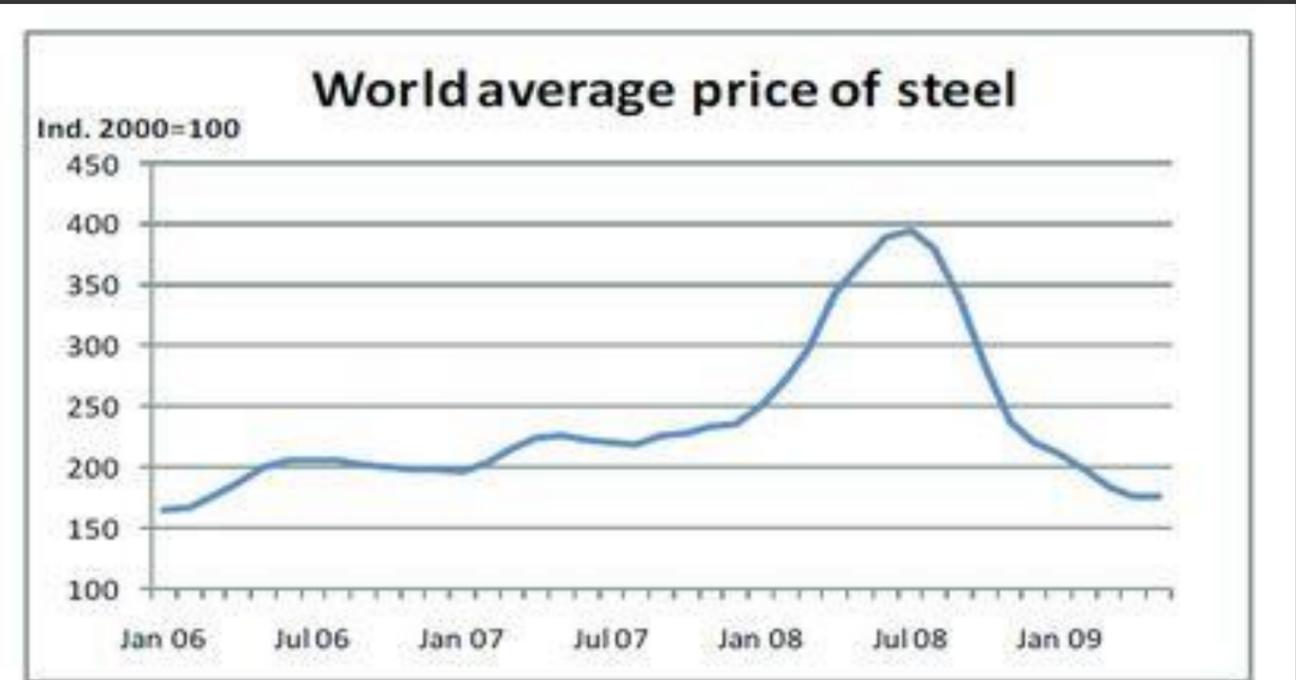


Lateral Component	Element Type	Assumptions	Modifiers
Special Reinforced Concrete Shear Walls	Thin-Shell	· No out-of-plane rigidity	· Self-weight factor set to 1.0
		· Shear wall fixed at ground level	· Moment in-plane set to 0.7 per ACI 318-11
		· Shell method is more accurate than frame method.	· Shear modifiers out-of-plane set to zero.
		· All floors are cracked (designed as "special" reinforced shear walls for ductility)	
Diaphragms	N/A	· Semi-rigid diaphragm	· Self-weight factor set to zero
		· Center of diaphragm mass is center of story mass	· Superimposed mass equal to total of floor assembly, facades, shear walls, and partitions.
		· Continuous over entire level.	
		· Penthouse loads applied at 6th story COM.	
		· Mass distributed uniformly	

Story	Px	Δ	le	Vx	Hsx	Cd	θ
1	51195.15	0.070991	1.5	365.84	192	5	0.01552
2	40158.28	0.221664	1.5	701.28	192	5	0.01983
3	29033.43	0.398928	1.5	671.38	168	5	0.03081
4	21719.82	0.601727	1.5	889.53	168	5	0.02624
5	14406.22	0.81551	1.5	1108.67	168	5	0.01892
6	6452.00	1.030091	1.5	1253.50	168	5	0.00947
7	640.00	1.24467	1.5	153.72	216	5	0.00720

	Base Shear X	Base Shear Y
ModalX Max	1679.357	1059.403
ModalY Max	728.667	3219.239
Seismic 1	-3411.224	0
Seismic 2	0	-4992.871
.85 Seismic 1	-2899.5404	0
.85 Seismic 2	0	-4243.94035
	X-Case	Y-Case
Scalar	1.726577732	1.31830546
Current 100%	96.6	96.6
Current 30%	28.98	28.98
Scale Factor 100%	166.787409	127.34831
Scale Factor 30%	38.2044922	50.036223





Courtesy of OECD Steel Committee.

Figure B-1 Standoff Distances – With Controlled Perimeter

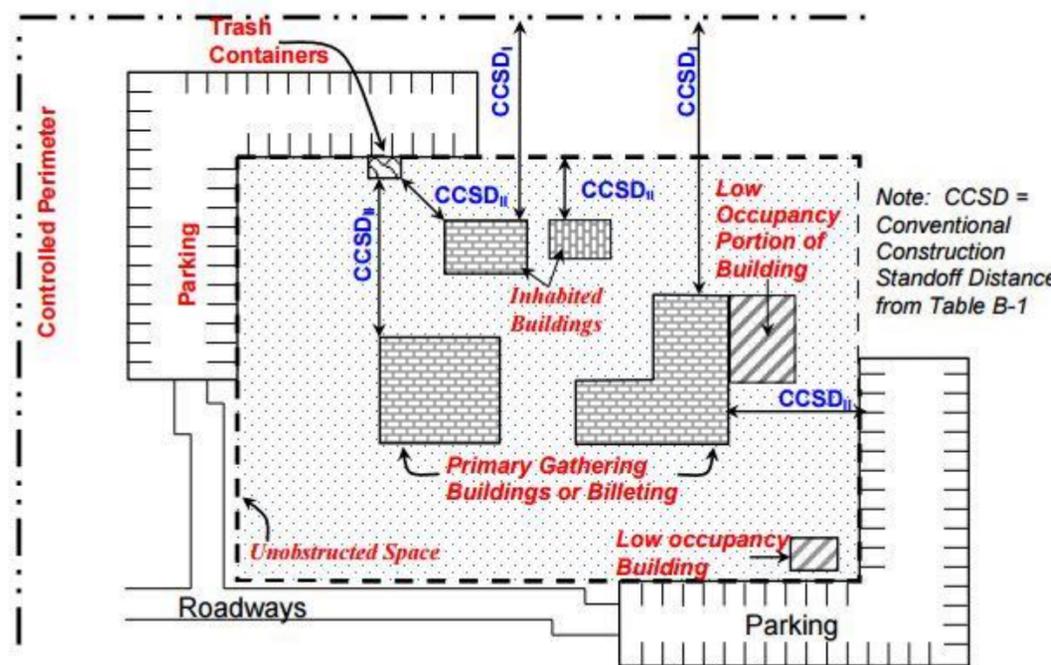


Figure 6-1 Access Control Zone Operated by Security Personnel

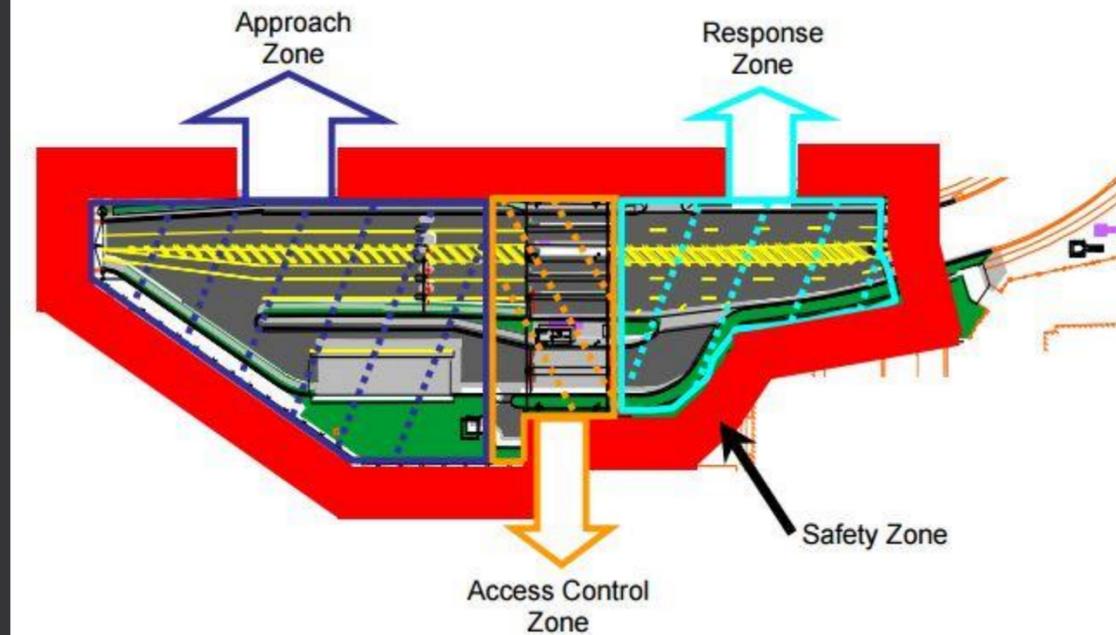
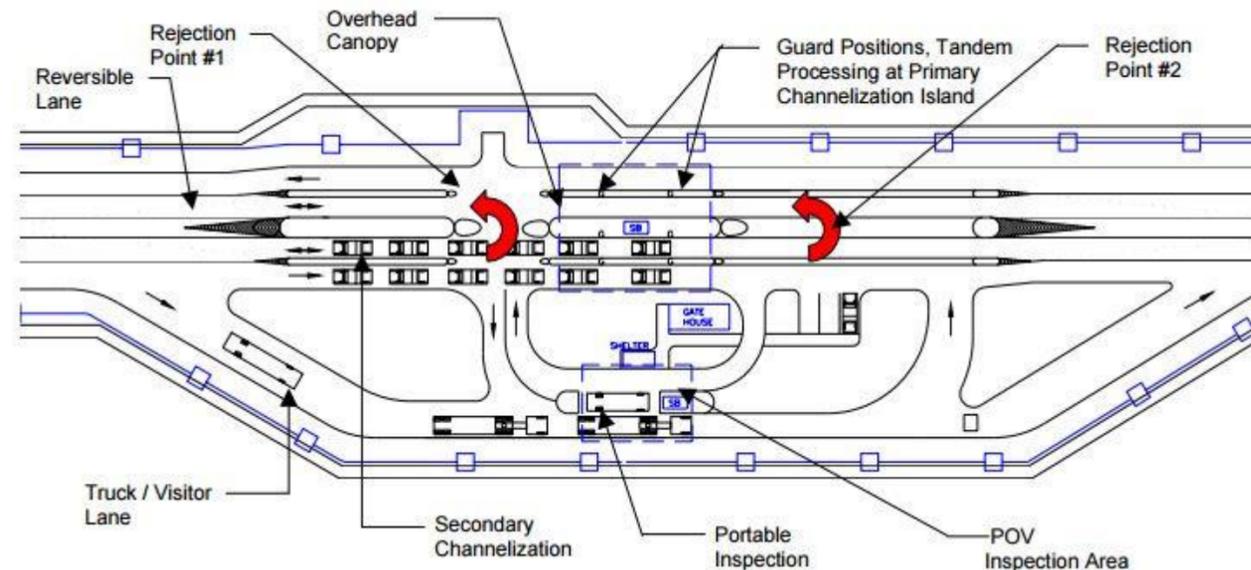


Table B-2 Conventional Construction Standoff Distances

Wall Type ^{(1), (6), (11)}	Column Letter							
	Without Controlled Perimeter Applicable Explosive Weight I ⁽⁵⁾				Within Controlled Perimeter Applicable Explosive Weight II ^{(1), (5), (11)}			
	Load Bearing Walls		Non-Load Bearing Walls		Load Bearing Walls		Non-Load Bearing Walls	
	A PG & BIL LLOP	B INHAB VLLOP	C PG & BIL LLOP	D INHAB VLLOP	E PG & BIL LLOP	F INHAB VLLOP	G PG & BIL LLOP	H INHAB VLLOP
Wood Studs – Brick Veneer	105 ft (32 m)	105 ft (32 m)	79 ft (24 m)	66 ft (20 m)	36 ft (11 m)	36 ft (11 m)	23 ft (7 m)	16 ft (5 m)
Wood Studs – EIFS	207 ft (63 m)	207 ft (63 m)	164 ft (50 m)	141 ft (43 m)	86 ft (26 m)	86 ft (26 m)	66 ft (20 m)	56 ft (17 m)
Metal Studs – Brick Veneer	187 ft (57 m)	187 ft (57 m)	207 ft ⁽³⁾ (63 m)	187 ft ⁽³⁾ (57 m)	75 ft (23 m)	75 ft (23 m)	82 ft ⁽³⁾ (25 m)	75 ft ⁽³⁾ (23 m)
Metal Studs – EIFS	361 ft (110 m)	361 ft (110 m)	420 ft ⁽³⁾ (128 m)	361 ft ⁽³⁾ (110 m)	151 ft (46 m)	151 ft (46 m)	167 ft ⁽³⁾ (51 m)	151 ft ⁽³⁾ (46 m)
Metal Panels	n/a ⁽²⁾	n/a ⁽²⁾	151 ft (46 m)	108 ft (33 m)	n/a ⁽²⁾	n/a ⁽²⁾	56 ft (17 m)	39 ft (12 m)
Girts	n/a ⁽²⁾	n/a ⁽²⁾	115 ft (35 m)	59 ft (18 m)	n/a ⁽²⁾	n/a ⁽²⁾	23 ft (7 m)	16 ft (5 m)
Reinforced Concrete	66 ft (20 m)	66 ft (20 m)	26 ft (8 m)	20 ft (6 m)	16 ft (5 m)	16 ft (5 m)	13 ft (4 m)	13 ft (4 m)
Unreinforced Masonry ⁽⁴⁾	262 ft (80 m)	262 ft (80 m)	125 ft (38 m)	33 ft (10 m)	80 ft (24 m)	80 ft (24 m)	26 ft (8 m)	16 ft (5 m)
Reinforced Masonry	86 ft (26 m)	86 ft (26 m)	30 ft (9 m)	20 ft (6 m)	30 ft (9 m)	30 ft (9 m)	13 ft (4 m)	13 ft (4 m)
European Block	164 ft (50 m)	164 ft (50 m)	59 ft (18 m)	30 ft (9 m)	39 ft (12 m)	39 ft (12 m)	23 ft (7 m)	16 ft (5 m)
(1) Roof Construction in Table 2-3 (1)	20 ft (6 m)				13 ft (4 m)			

Table 2-3 Conventional Construction Parameters

Wall or Roof Type ⁽¹⁾	Analysis Assumptions ^(2, 9)						
	Sections	Span	Spacing	Support Condition	Supported Weight ⁽⁵⁾	Reinforcement Ratio	Min. Static Material Strength
Wood Studs – Brick Veneer	2x4 & 2x6 in (50x100 & 50x150 mm)	8 – 10 ft (2.4 - 3 m)	16 - 24 in (400 – 600 mm)	S-S	44 psf (215 kg/m ²)	N/A	875 psi (6 MPa)
Wood Studs – EIFS	2x4 & 2x6 in (50x100 & 50x150 mm)	8 – 10 ft (2.4 - 3 m)	16 - 24 in (400 - 600 mm)	S-S	10 psf (49 kg/m ²)	N/A	875 psi (6 MPa)
Steel Studs – Brick Veneer ⁽³⁾	600S162-43 600S162-54 600S162-68	8 – 12 ft (2.4 – 3.7 m)	16 - 24 in (400 – 600 mm)	S-S	44 psf (215 kg/m ²)	N/A	50,000 psi (345 MPa)
Steel Studs – EIFS ⁽³⁾	600S162-43 600S162-54 600S162-68	8 – 12 ft (2.4 – 3.7 m)	16 - 24 in (400 – 600 mm)	S-S	10 psf (49 kg/m ²)	N/A	50,000 psi (345 MPa)
Metal Panels ⁽⁶⁾ (in wall or roof construction)	1.5 – 3 in (38 - 76 mm) 22, 20, & 18 ga	4 – 8 ft (1.2 - 2.4 m)	N/A	S-S	10 psf (49 kg/m ²)	N/A	33,000 psi (228 MPa)
Girts ⁽⁶⁾ (in wall or roof construction)	8Z3 & 10Z3 16, 14, & 12 ga	20 – 25 ft (6 – 7.6 m)	6 – 8 ft (1.8 – 2.4 m)	S-S	5 psf (24 kg/m ²)	N/A	50,000 psi (345 MPa)
Reinforced Concrete ⁽⁷⁾	≥ 6 in (≥ 150 mm)	12 – 20 ft (3.7- 6 m)	N/A	S-S, One way flexure	10 psf (49 kg/m ²)	≥ 0.0015	3,000 psi (21 MPa)
Unreinforced Masonry ^(4, 9)	6 – 12 in (150 – 300 mm)	8 – 12 ft (2.4 – 3.7 m)	N/A	S-S, One way flexure	10 psf (49 kg/m ²)	0	1,500 psi (10 MPa)

Component	Element Properties	Assumptions
Steel Studs	800S162-54 Section	Bending about strong (X-X) axis
	A653, Grade 33 (cold-formed steel)	No Dynamic Axial Load
		Standard Web Punch Outs
		Simply supported
Veneer Wall	4 in. Brick	40 psi allowable tension stress
	S or M type mortar	
General Wall		32 ft. Tall
		100 ft. Wide
		Flexural and Tension Membrane
		1% Critical Damping

Table 3-1 Component Damage Levels Relationship to Response Limits

Component Damage Level	Relationship to Response Limits
Blowout	Response greater than B4.
Hazardous Failure	Response between B3 and B4
Heavy Damage	Response between B2 and B3.
Moderate Damage	Response between B1 and B2.
Superficial Damage	Response is less than B1.

Wall System	Expected Damage Level											
	Superficial			Moderate			Heavy			Hazardous		
	Δ_{max}	μ_{max}	θ_{max}	Δ_{max}	μ_{max}	θ_{max}	Δ_{max}	μ_{max}	θ_{max}	Δ_{max}	μ_{max}	θ_{max}
Conventional stud wall with tensile membrane capacity (Army Corps of Engineers, 2008b)	-	0.5	-	-	1	0.5°	-	2	2°	-	5	5°
SEB Wall system developed by SGH (Aviram et al., 2012)	H/30	5	7°	H/20	8	10°	H/15	12	12°	H/10	15	15°

Metal Stud Wall

Results Summary			
θ_{max}	=	-1.1	deg.
μ	=	1.31	
X_{max}	=	1.80	in at time = 35.70 msec
X_{min}	=	-1.90	in at time = 120.12 msec
R_{max}	=	0.87	psi at time = 24.36 msec
R_{min}	=	-0.85	psi at time = 120.12 msec

Peak Dynamic Reactions	
$V_{max,Long}$	= 0.87 psi
$V_{max,Short}$	= 0.00 psi
Strain Rate to Yield*	
Strain Rate	= 0.064 1/sec

*Yield when deflection= X_E at bottom of SDOF Properties on Input Sheet, or max. deflection if no yield

