Prince Frederick Hall

University of Maryland
College Park, MD

Christopher Cioffi [Structural]

AE Senior Thesis Spring 2014

Advisor: Professor Sustersic

Prince Frederick Hall Introduction

Building Statistics

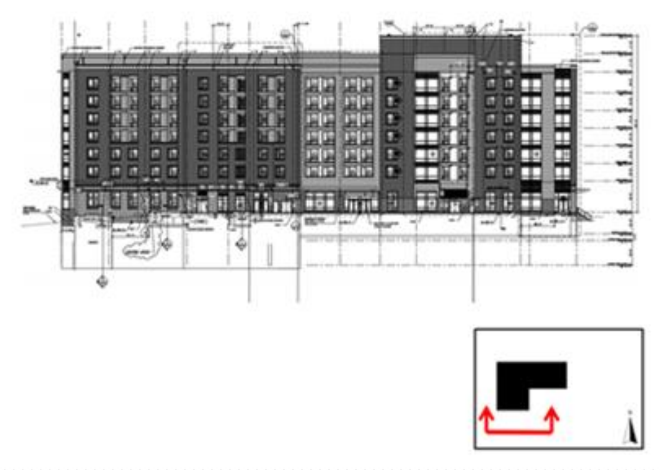
- Multi-purpose Dormitory
- 185,000 gSF
- 7 Stories Above Ground/ 1 Underground
- Gravity System: Two Way Concrete Slabs w/ Concrete Columns
- Lateral: Ordinary Concrete Shear Walls

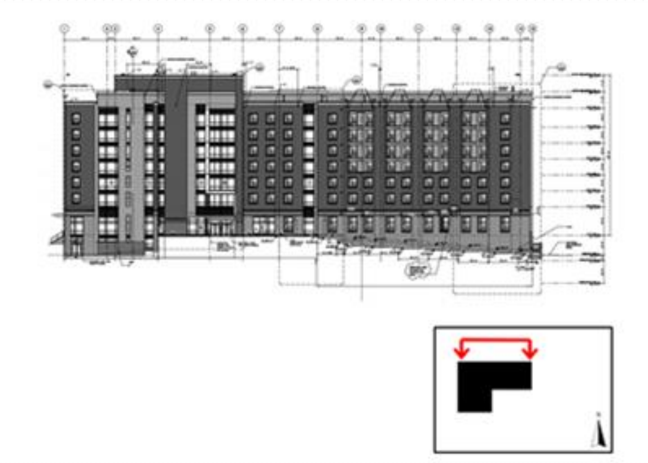
Project Team

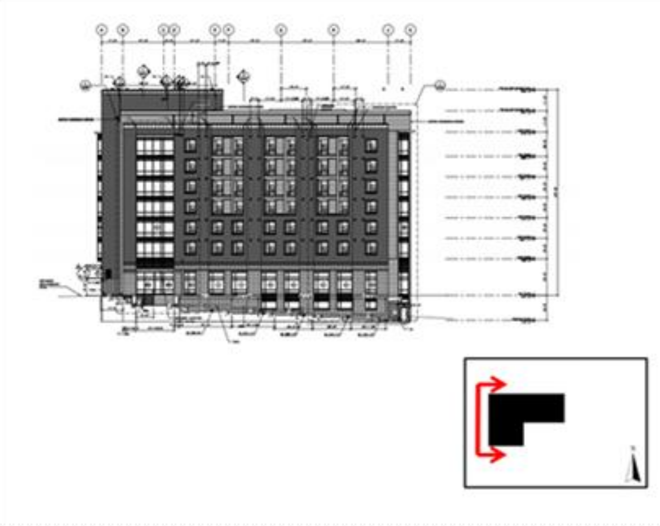
- Architects: WDG Architecture
- Contractor: Clark Construction
- Civil Engineers: Site Resources Inc.
- Structural Engineers: Cagley & Associates

Prince Frederick Hall Introduction

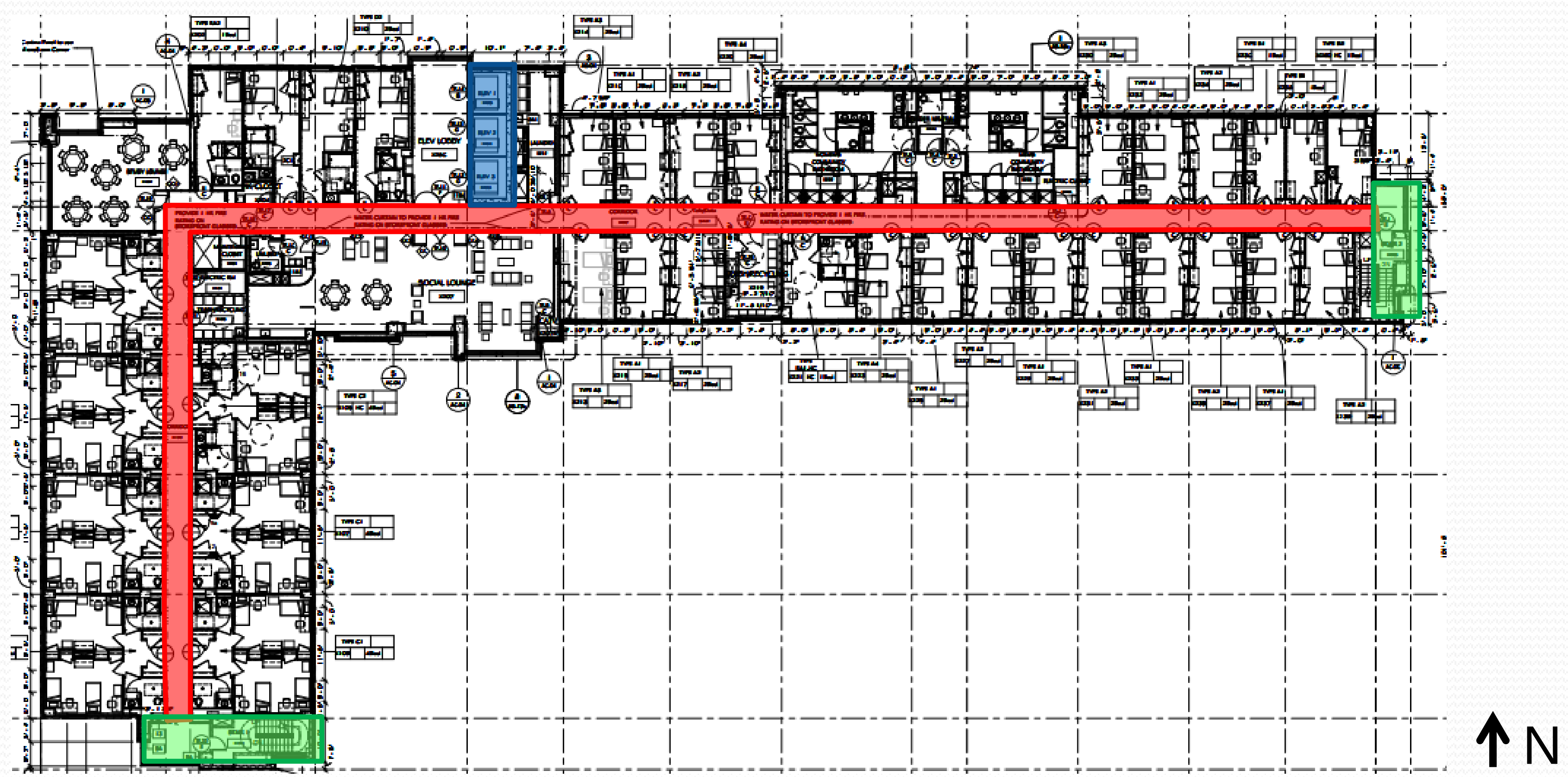
Building Elevations:





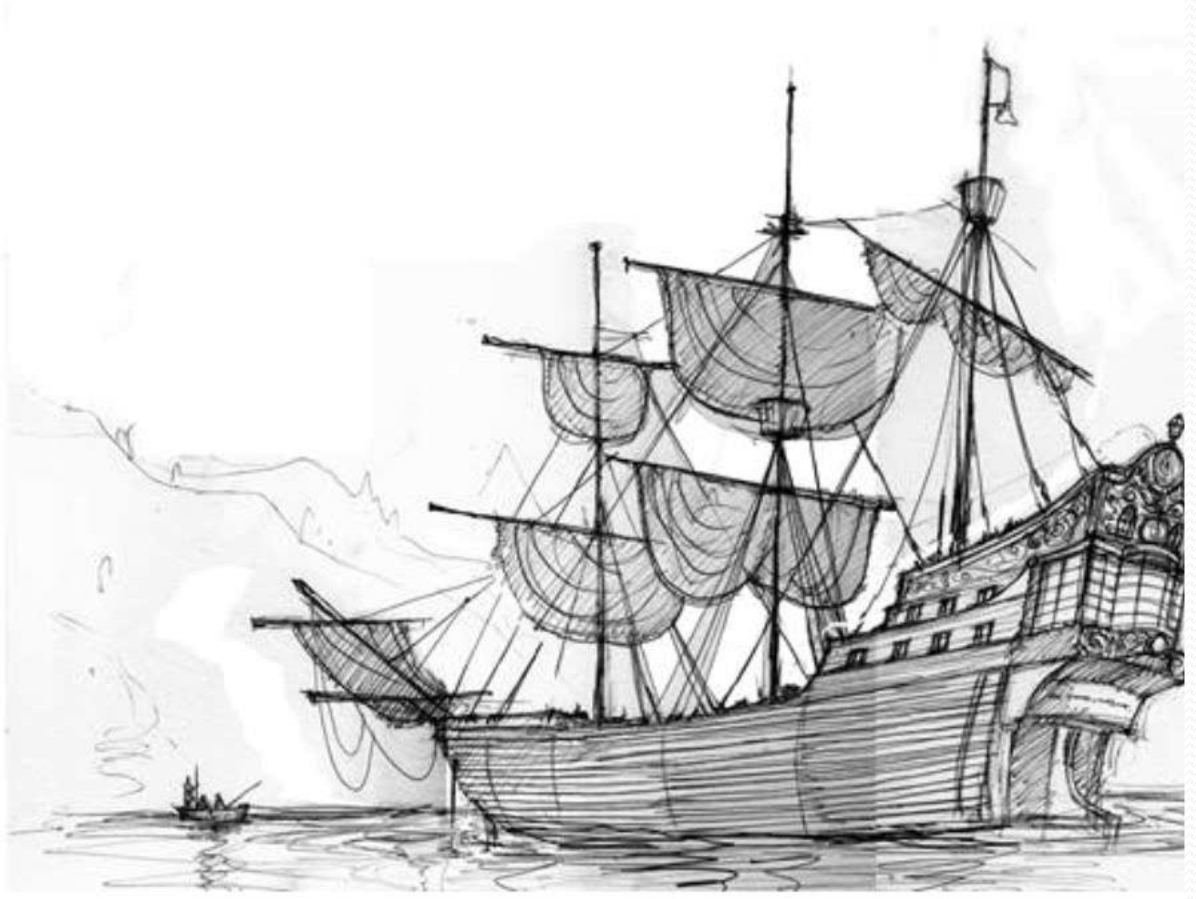


Typical Floor 2-7 Plan:



=Elevators =Hallway =Stairwells


Blackbeard's Oasis
Indoor Water Park and Hotel



scenario

Design a brand new **Luxury Family Resor**t:

With on site **Entertainment**

Luxury Accommodations

proposal

ARCH:

1. Pick New Site
2. Design New Floor Plans Hotel
3. Design Water Park Floor Plans

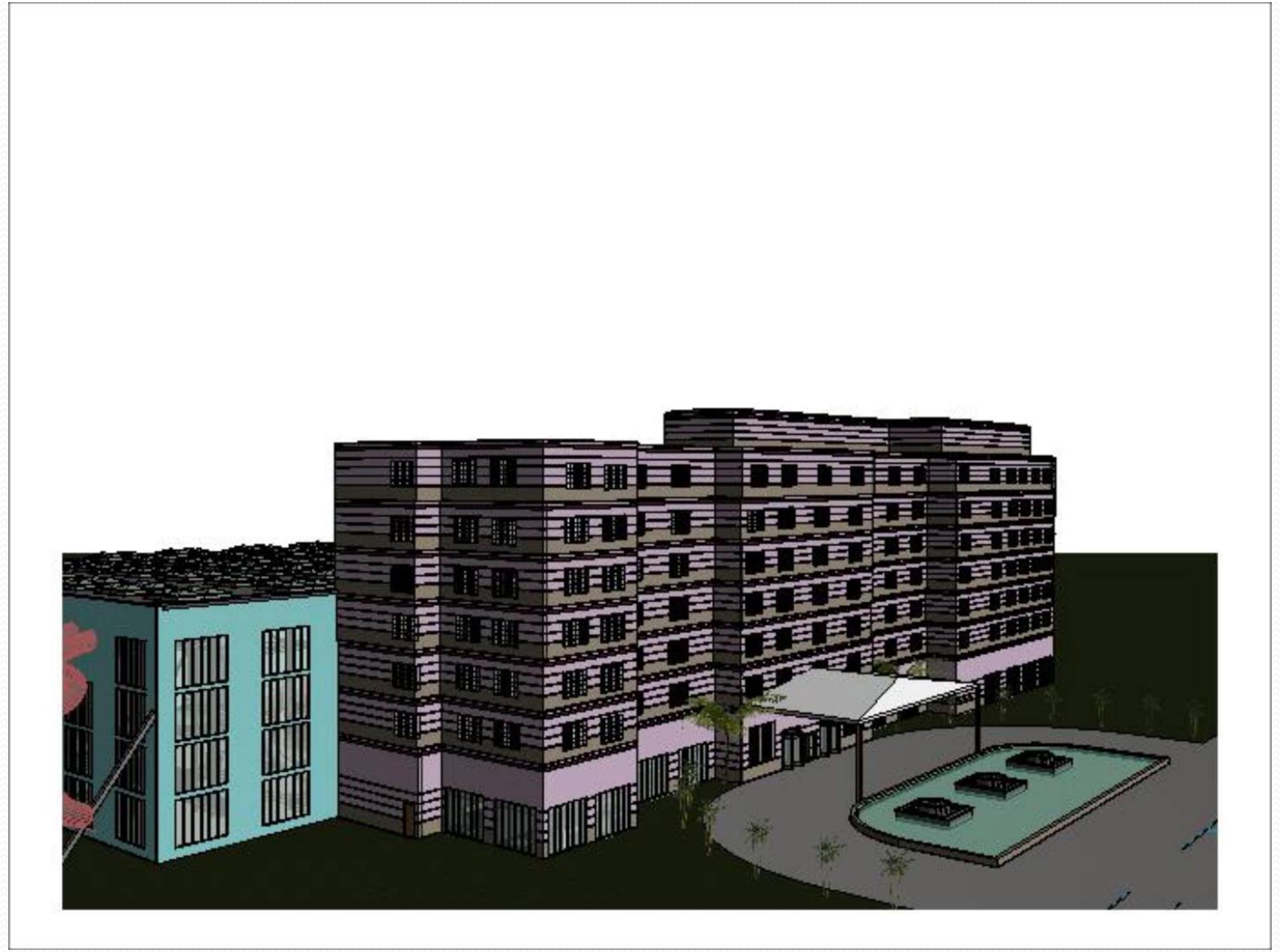
proposal

STRUC:

1. Design Water Slide Structure
2. Design Water Park Gravity/Lateral Systems
3. Re-design Hotel Gravity/Lateral Systems

Hotel Information

- Hotel Size: 185,000 gSF
- Stories: 7 stories, 1 underground
- 234 Guest Rooms
- Arcade
- Bar/Night Club

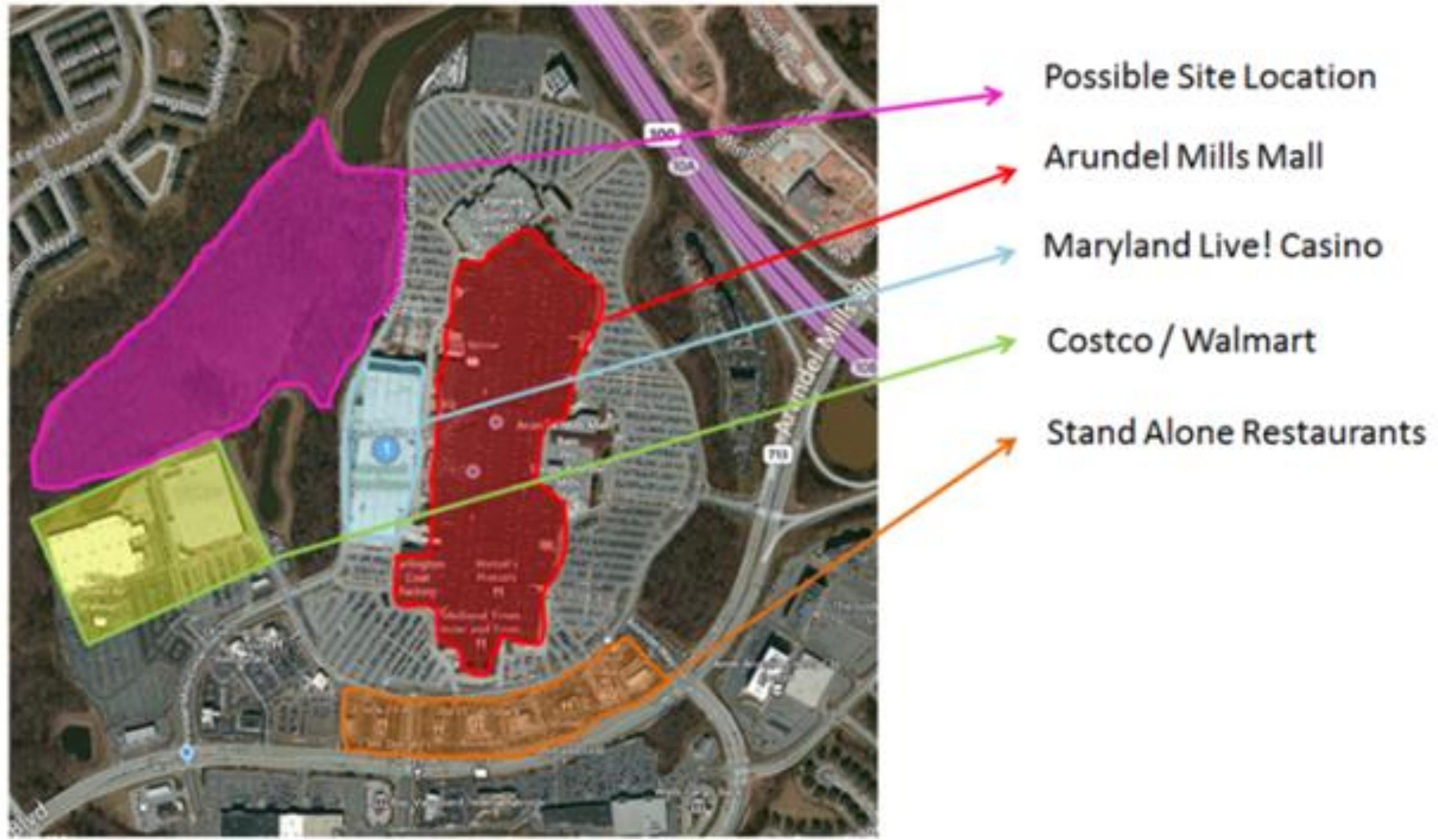


Indoor Water Park Information

- Indoor Water Park: 45,000 gSF
- Stories: 4 stories tall
- Over 10 Water Slides and Attractions
- Large 120,000 Gallon Wave pool
- Thrilling Speed Slides

new site:

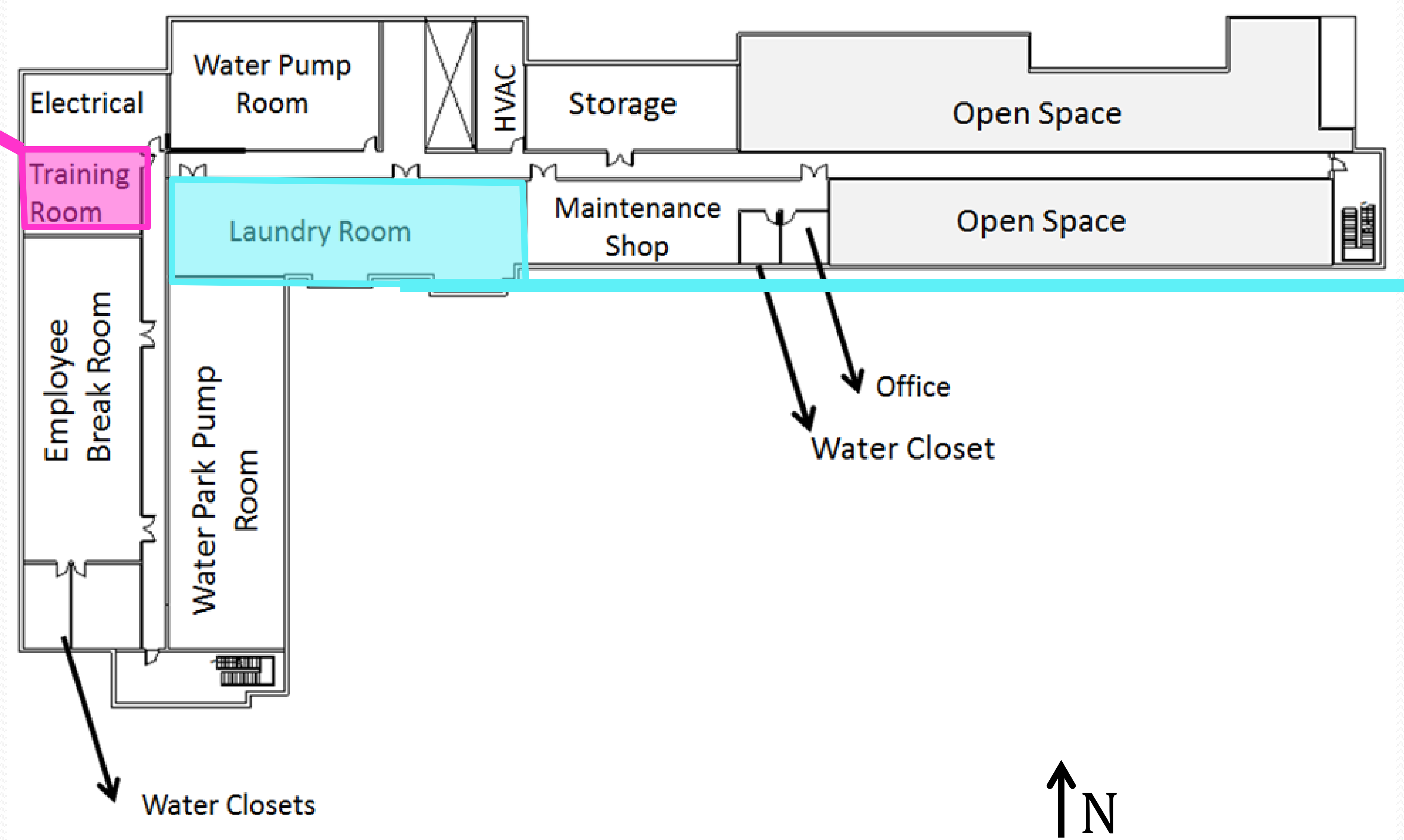
Arundel Mills Circle
Hanover, Maryland



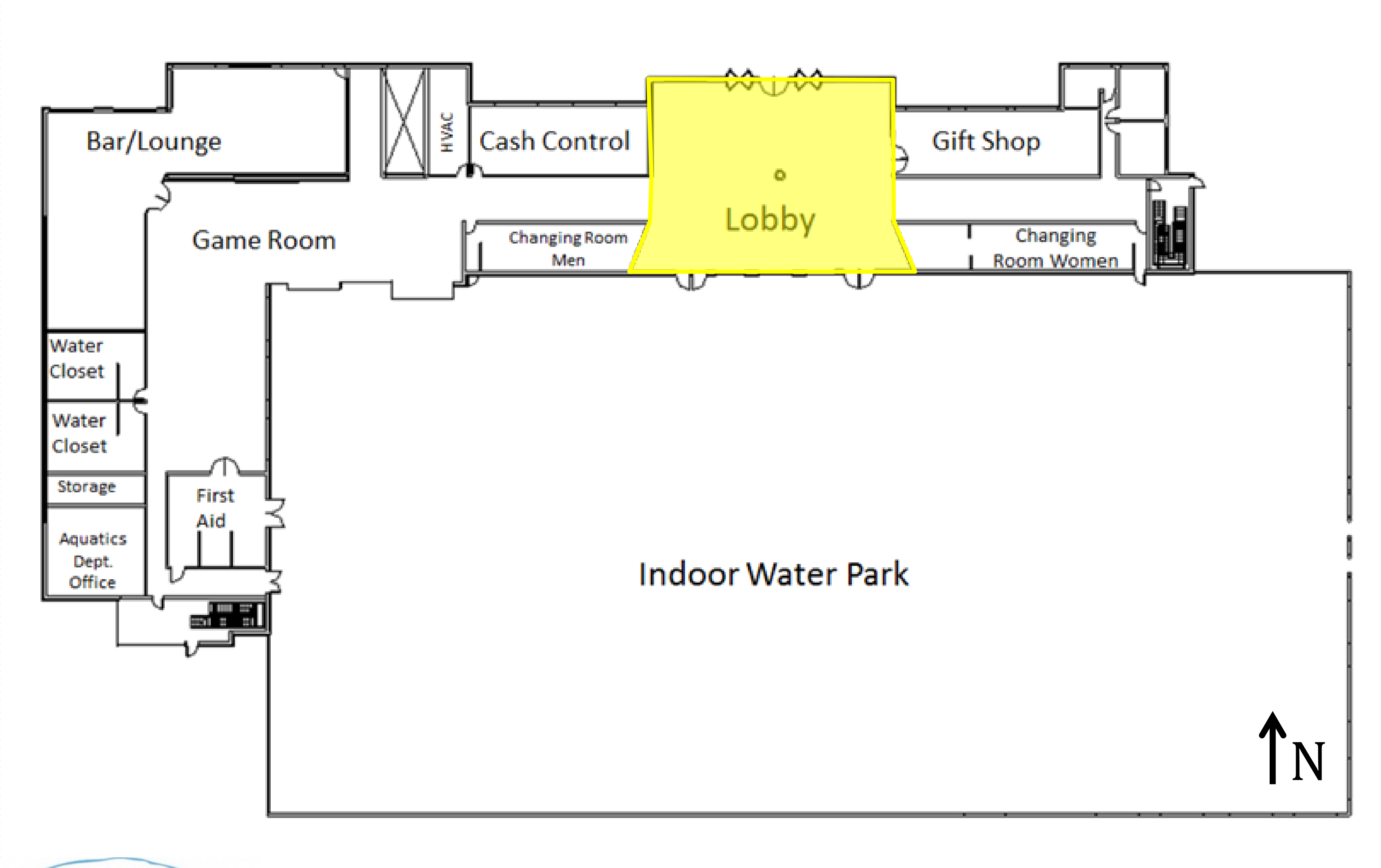
Site Amenities

- Awesome Shopping
- Diverse Dinning
- Entertainment
- Casino Gambling
- Prime Location

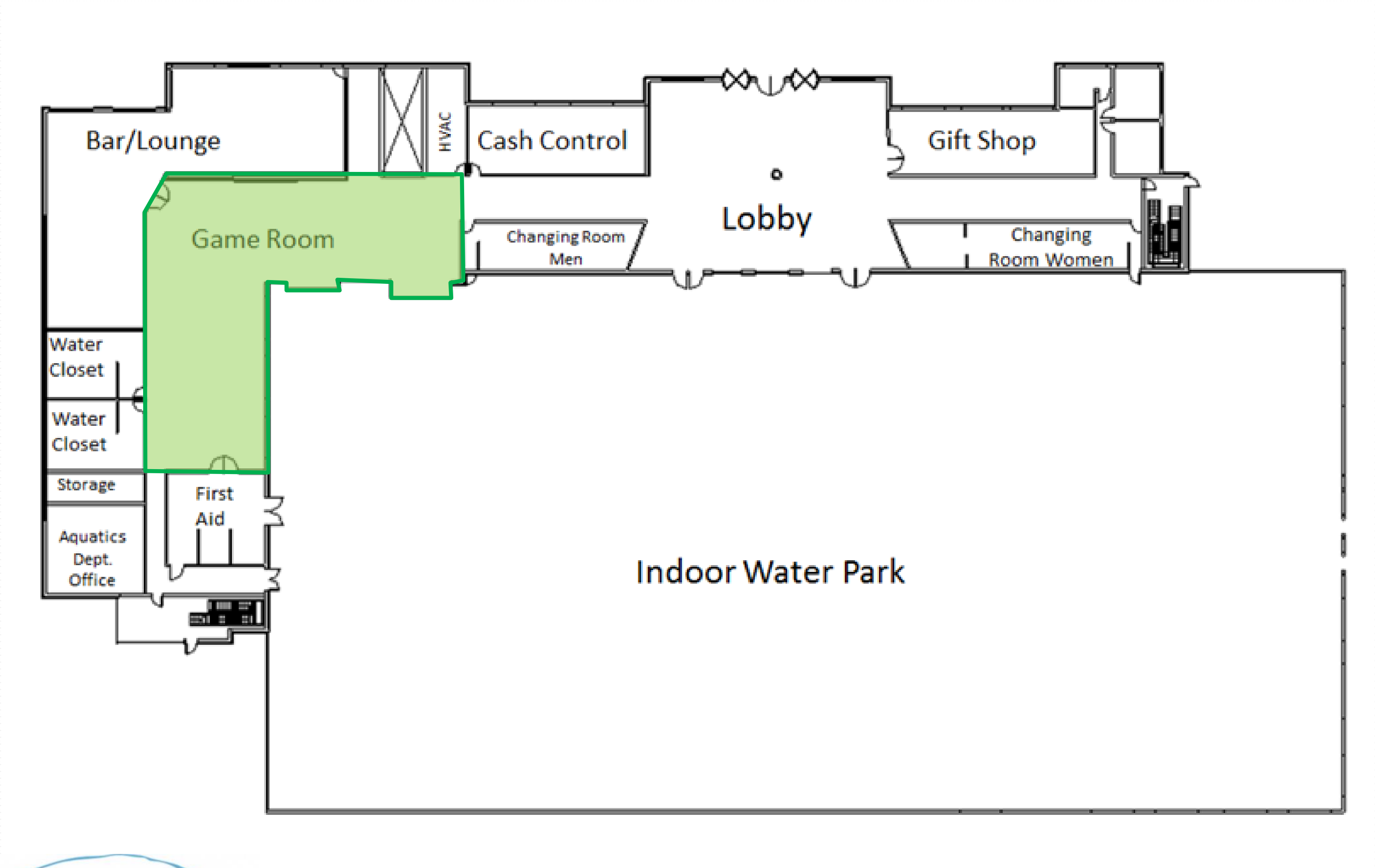
Arch Floor Plan: SCUB LEVEL



Arch Floor Plan: First Floor Plan

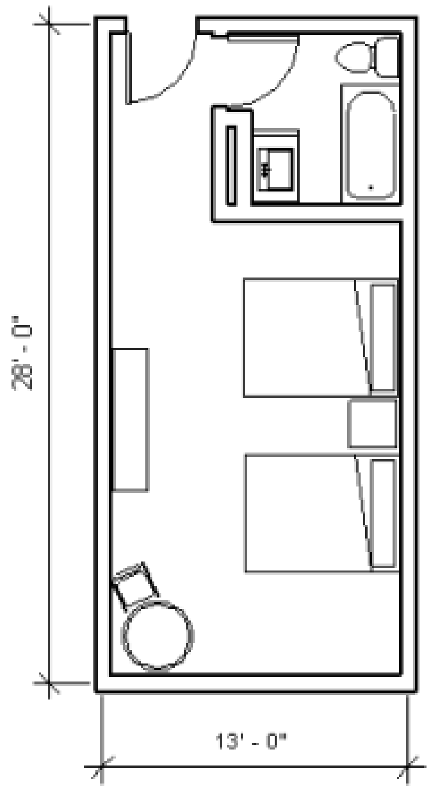


Arch Floor Plan: First Floor Plan

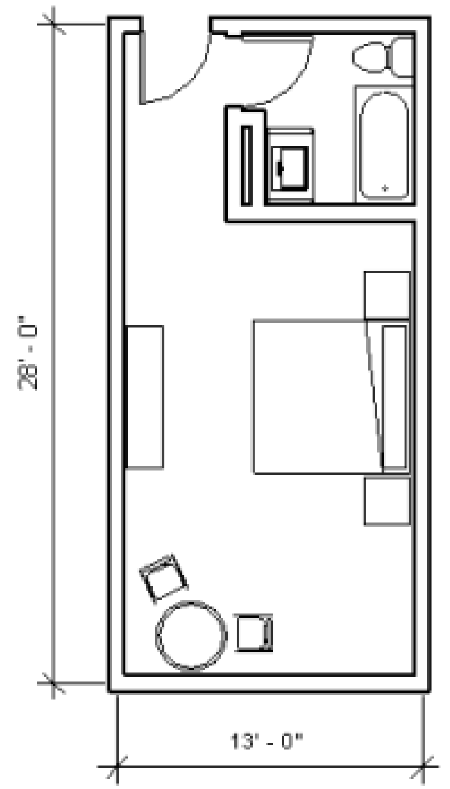


Arch Floor Plan: Floors 2-7

Standard Queen Room (364 sft)



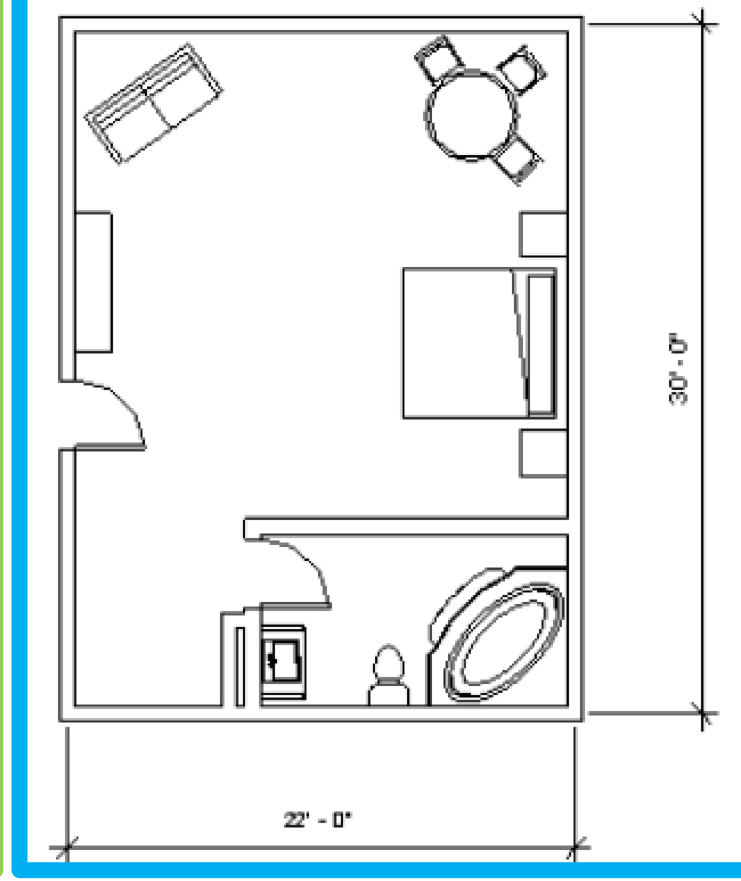
Standard King Room (364 sft)



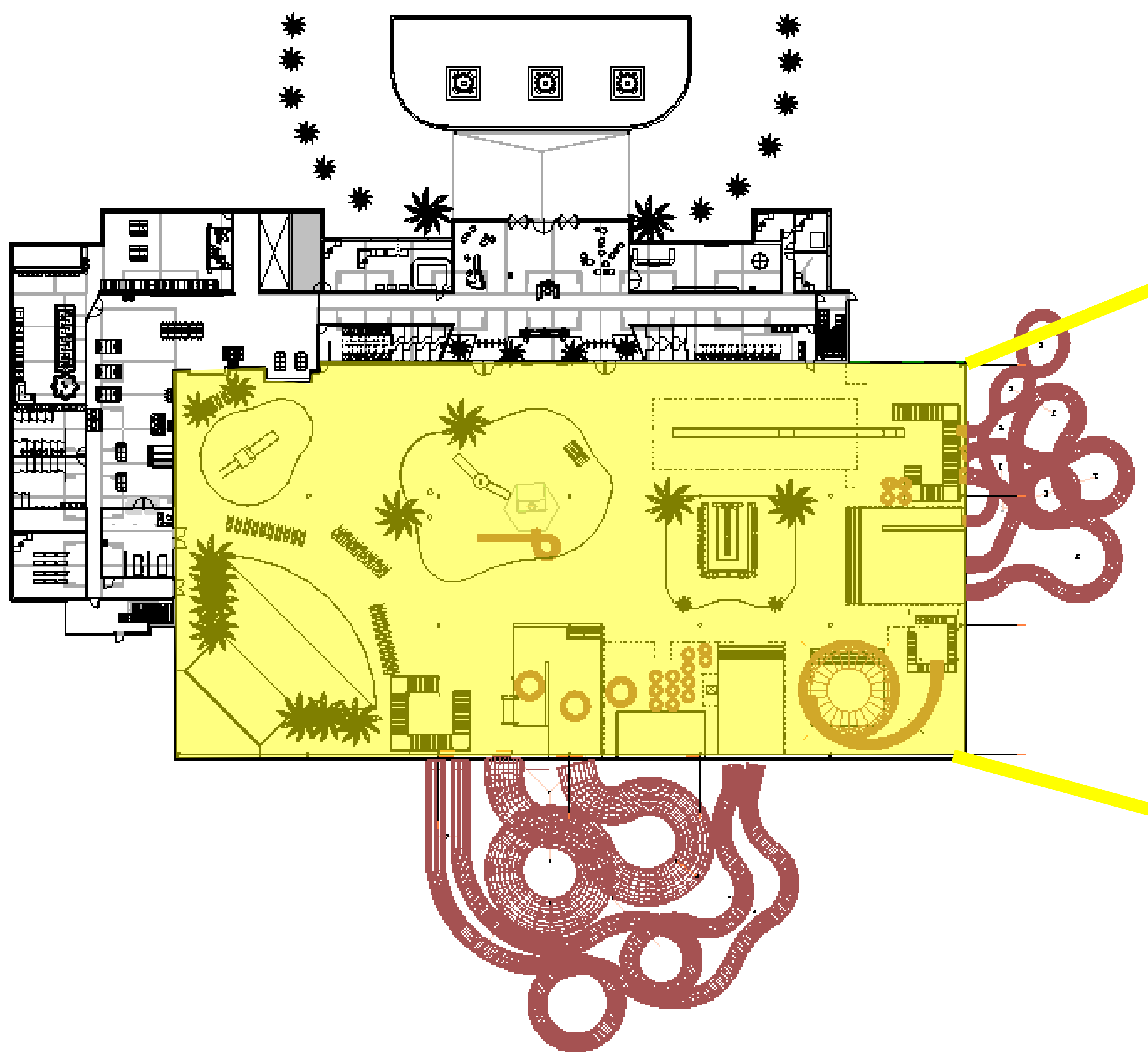
↑N

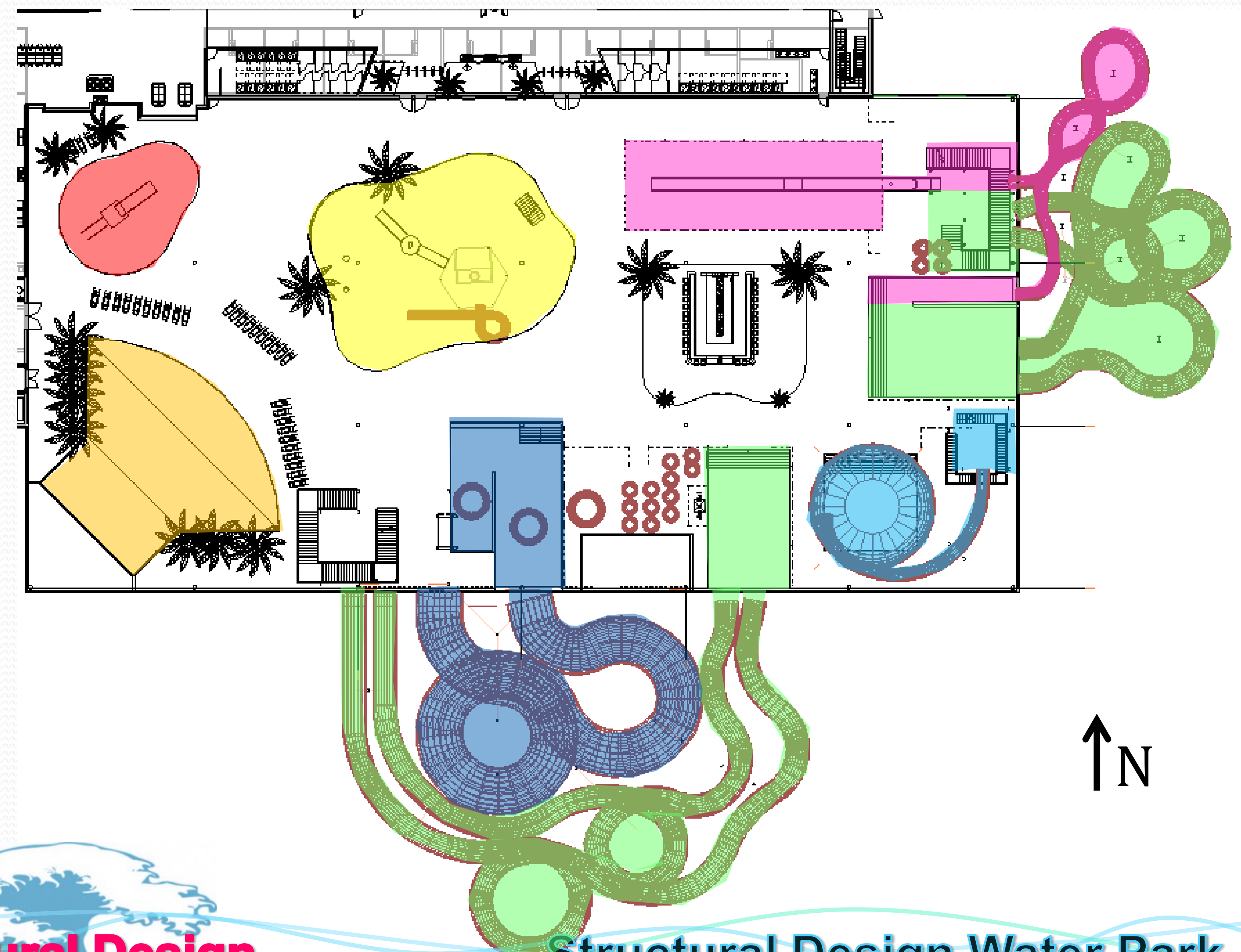
Suite (495 sft)

Luxury Suite (660sft)



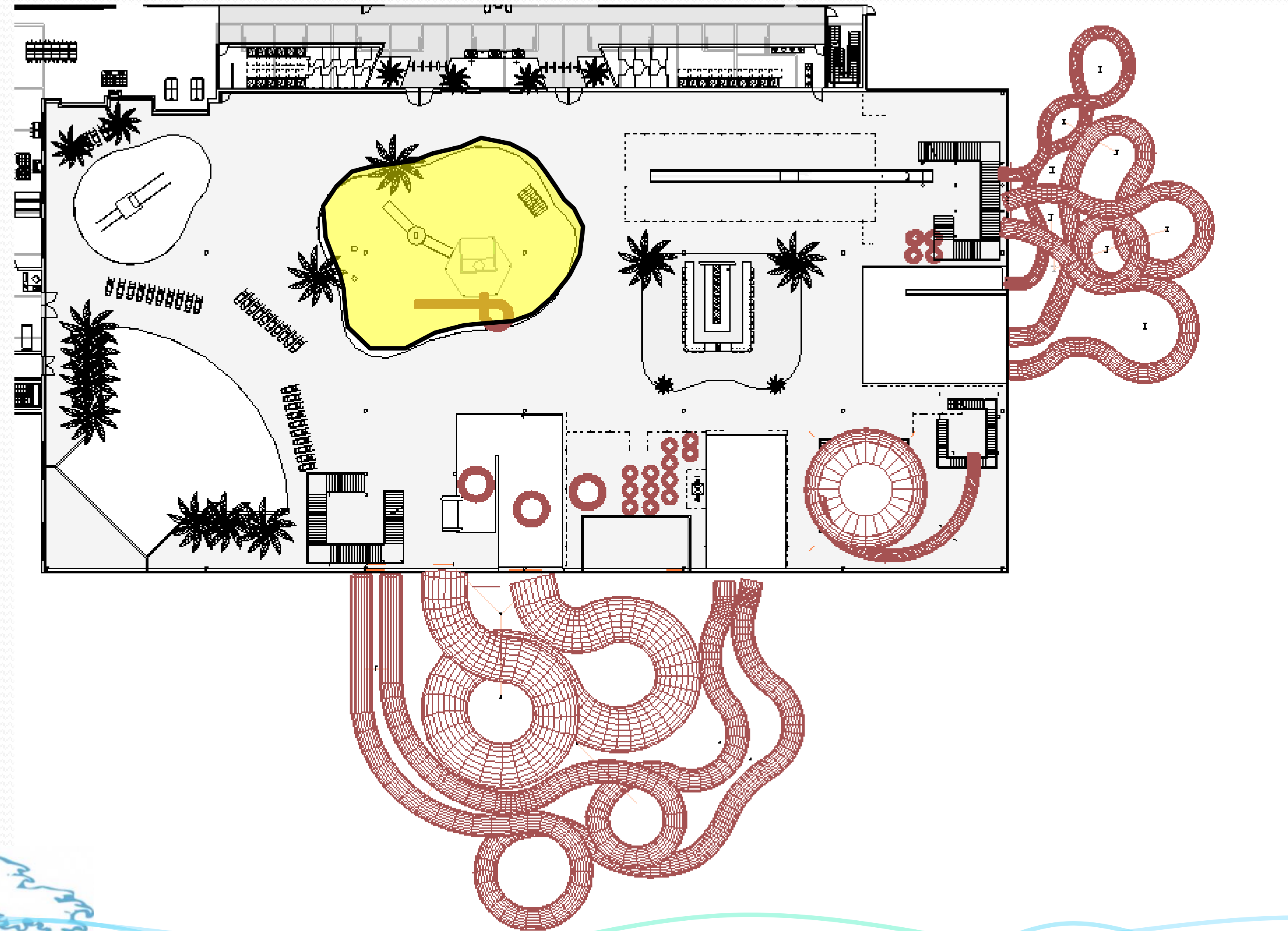
Arch Floor Plan: Indoor Water Park



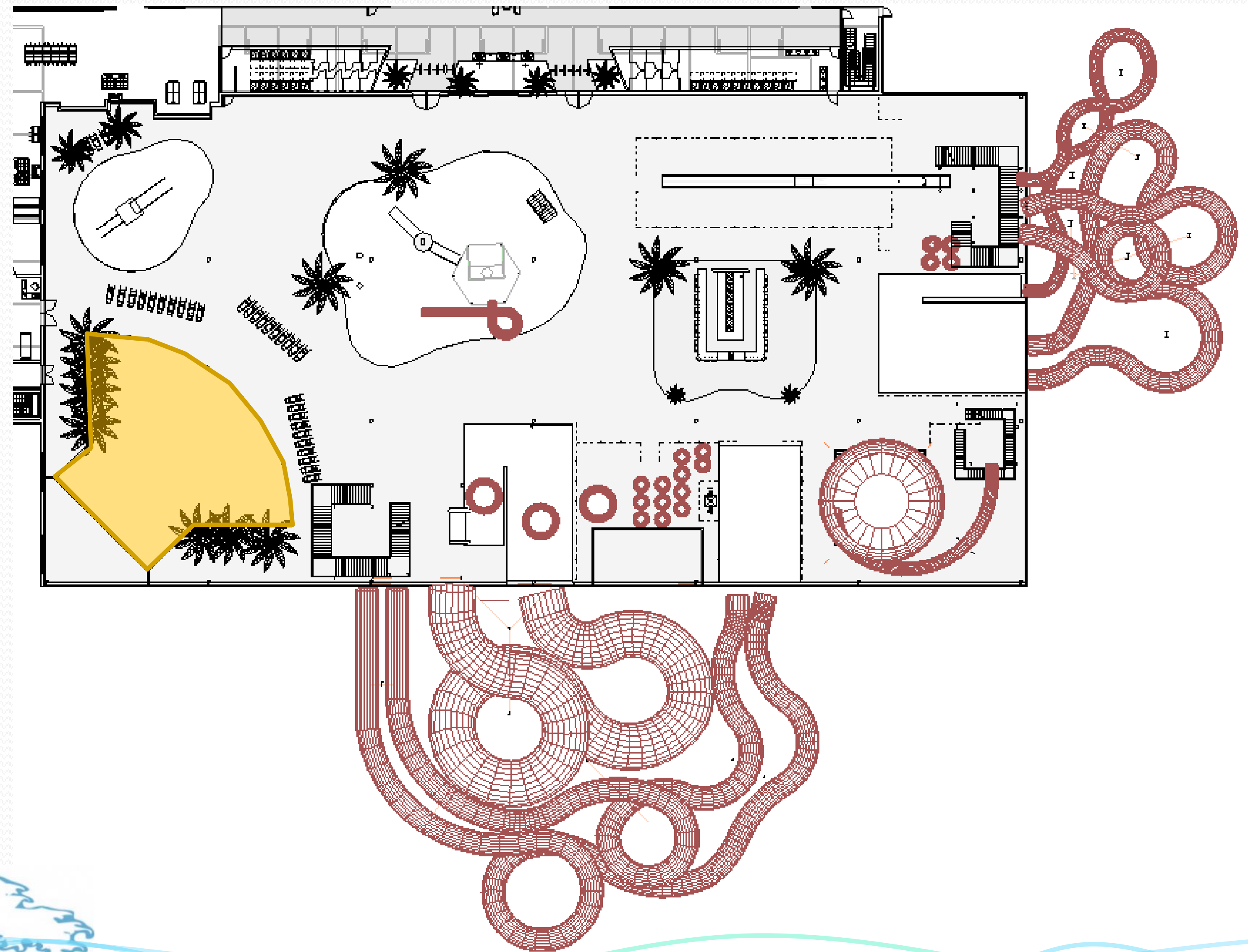


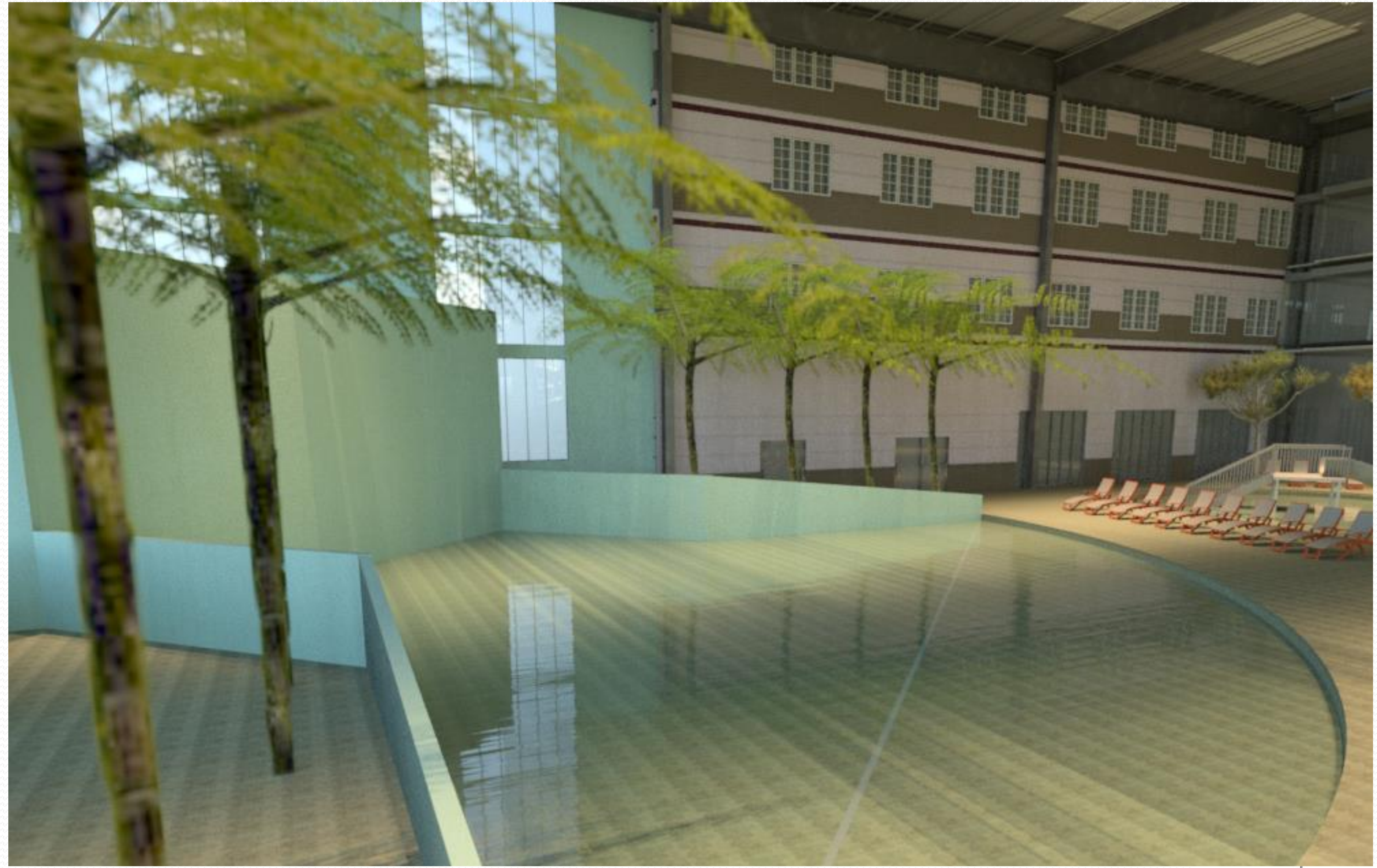
- Children's Slide and Pool
- Wave Pool
- Family Splash Tower
- Racing Tube Slides
- Family Raft
- Pro Bowl
- Speed Slides

Family Splash Tower

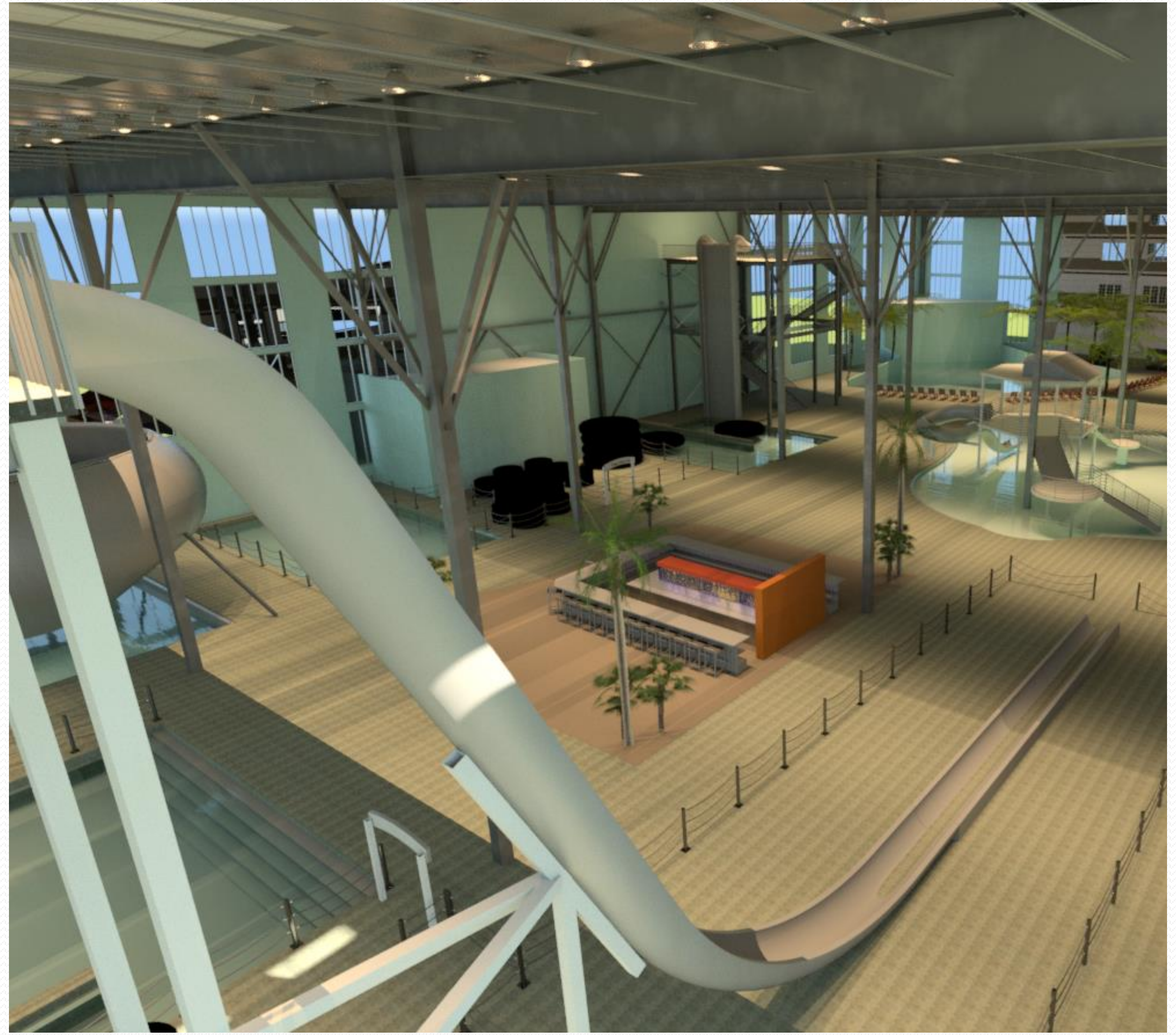


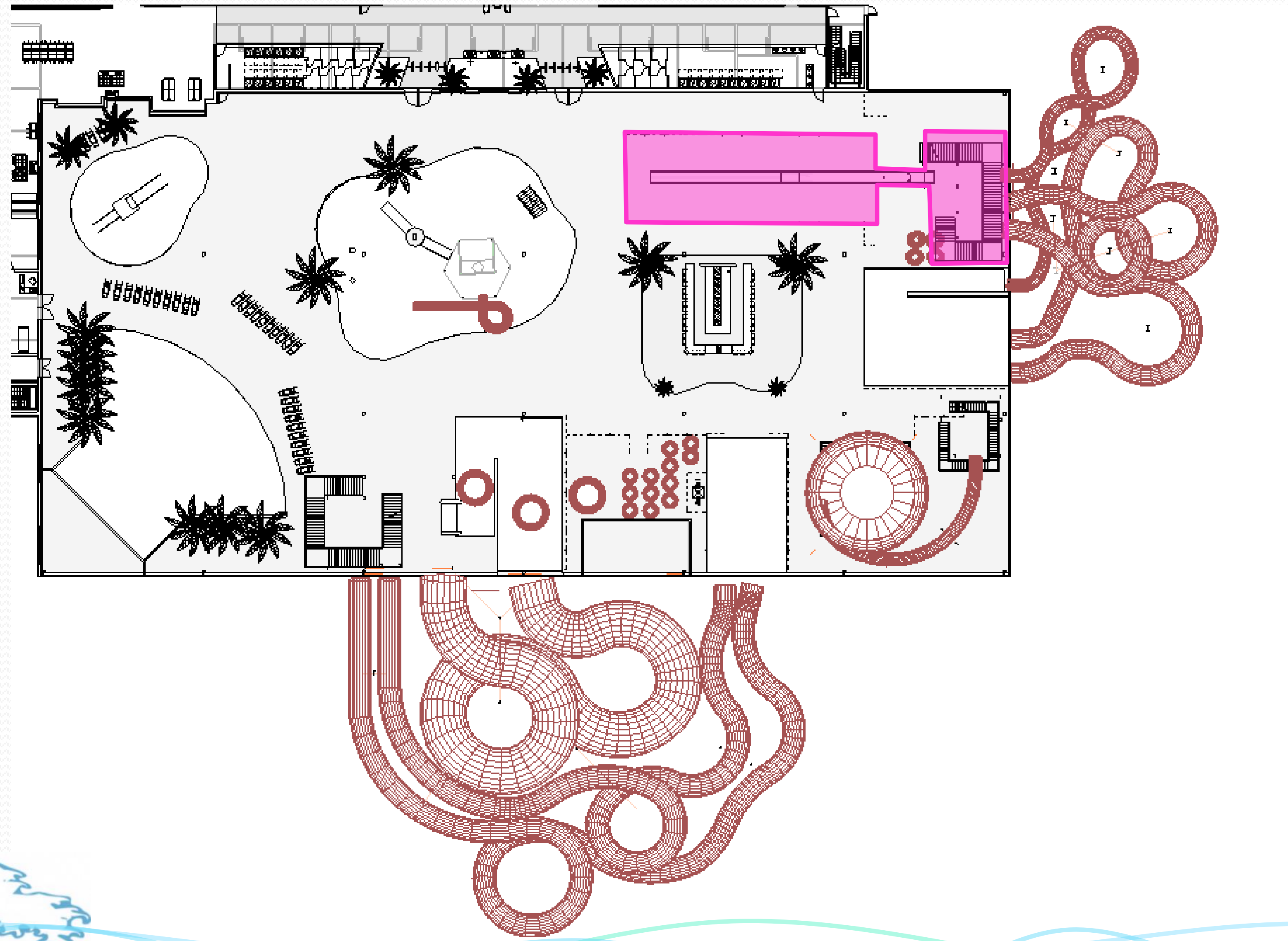
Blue Lagoon Wave Pool

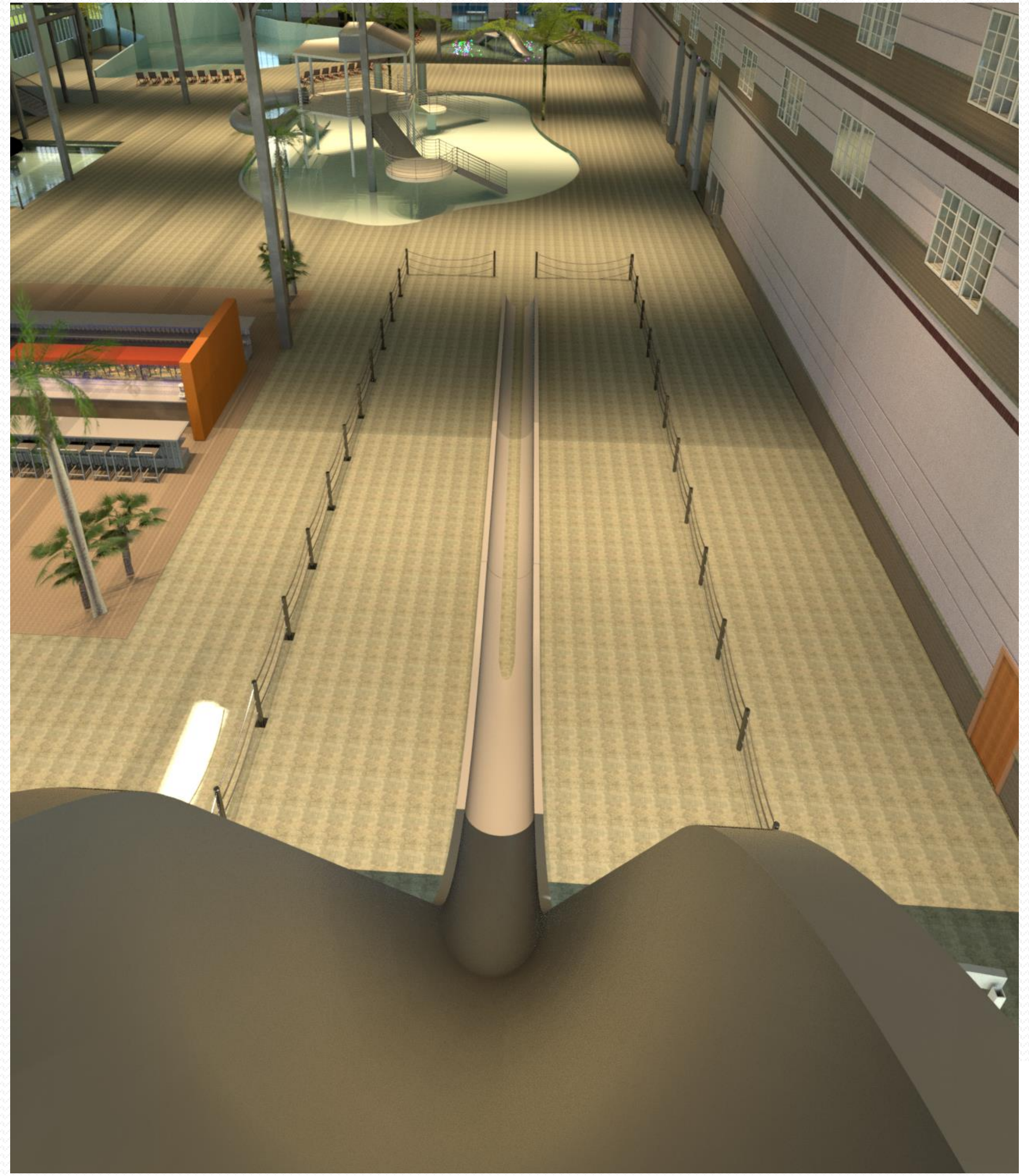




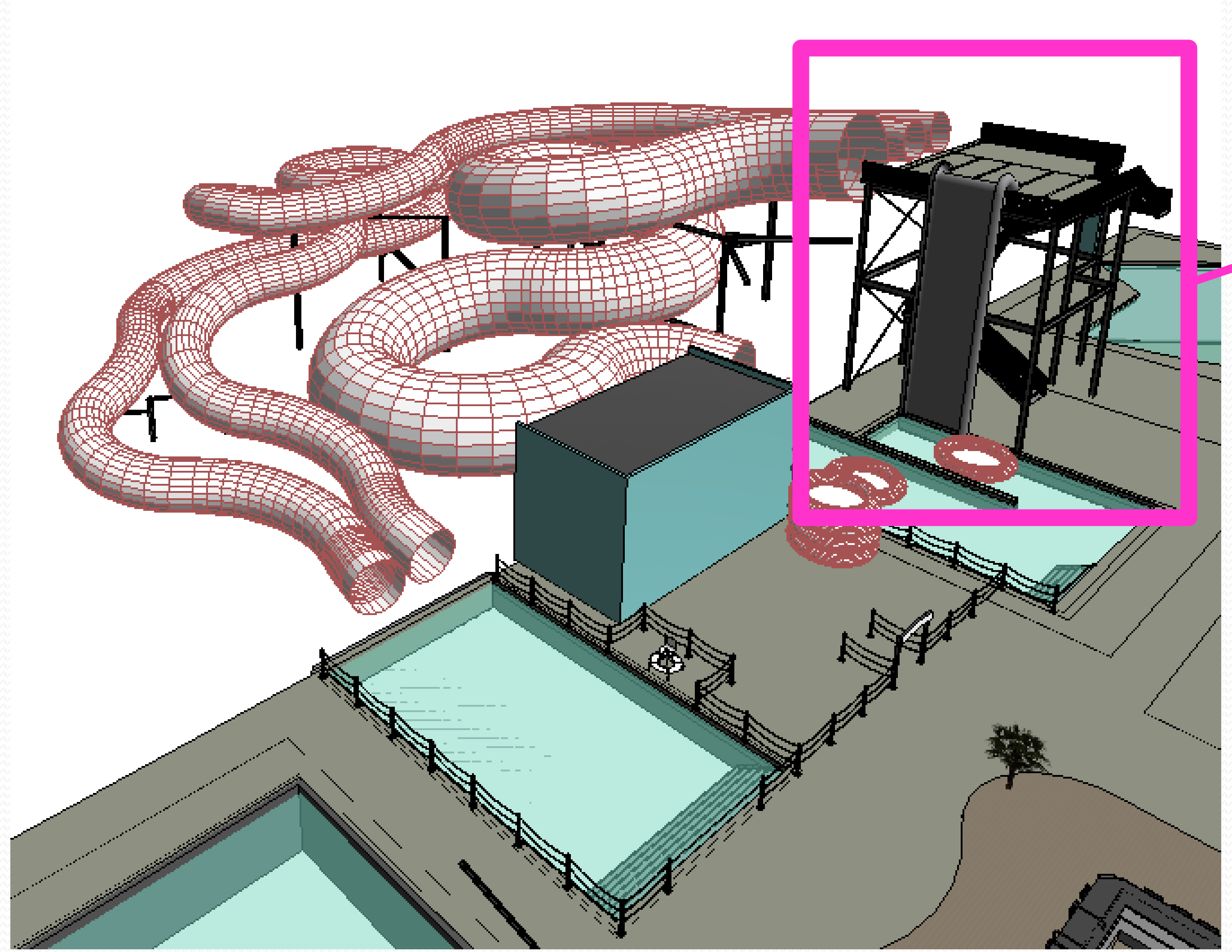
Free-FALL (Speed Slide)

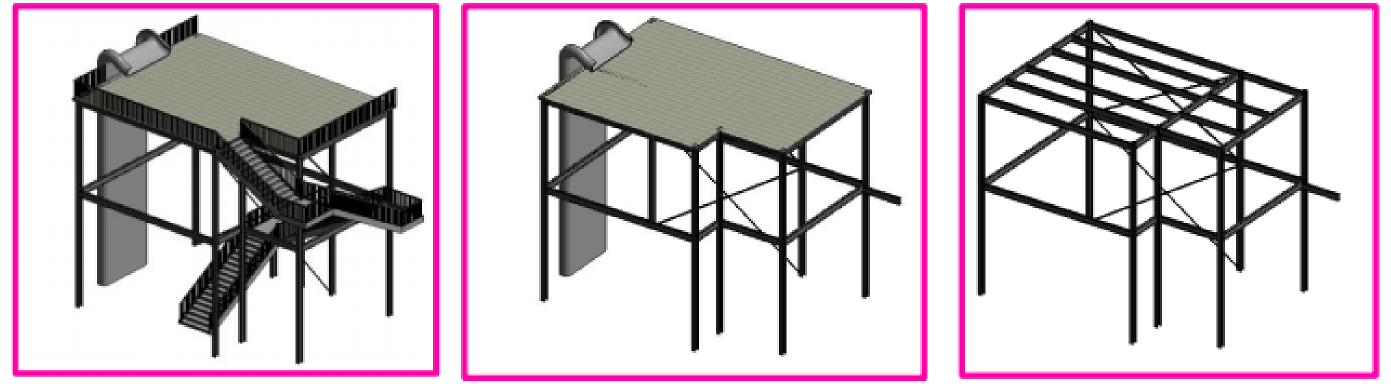




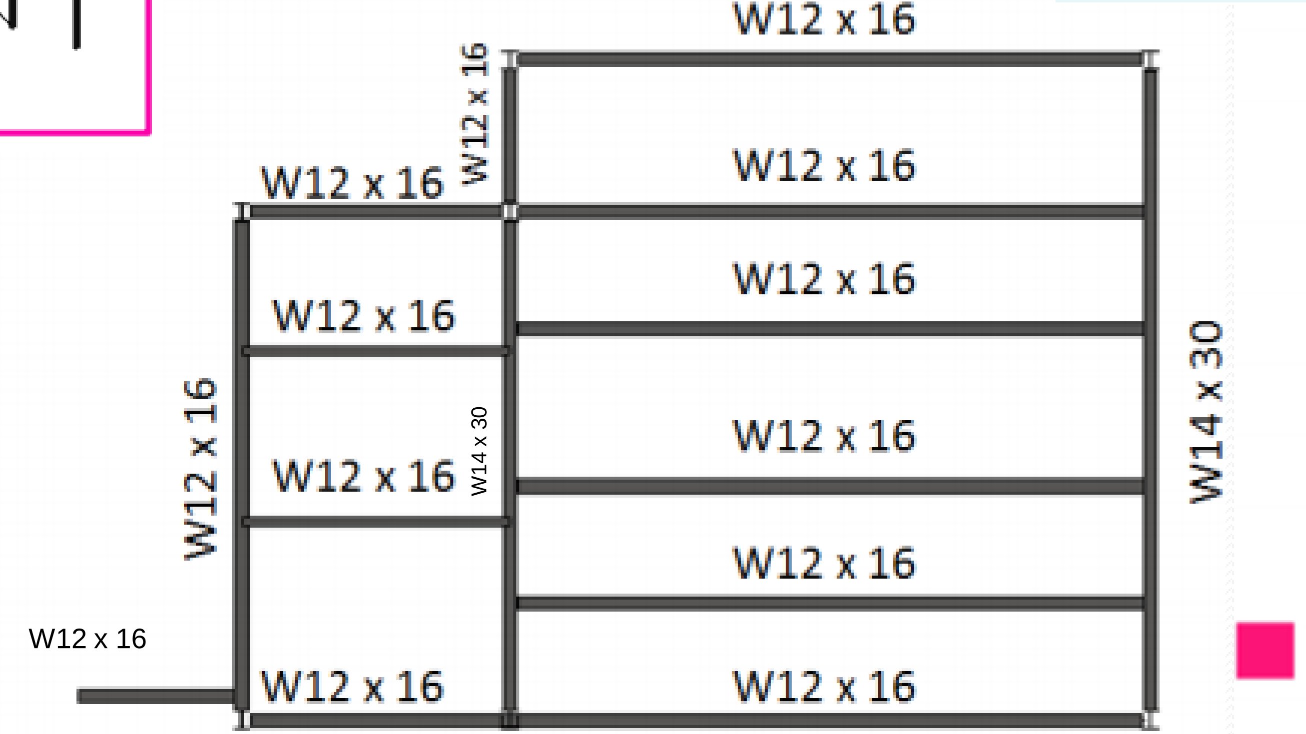


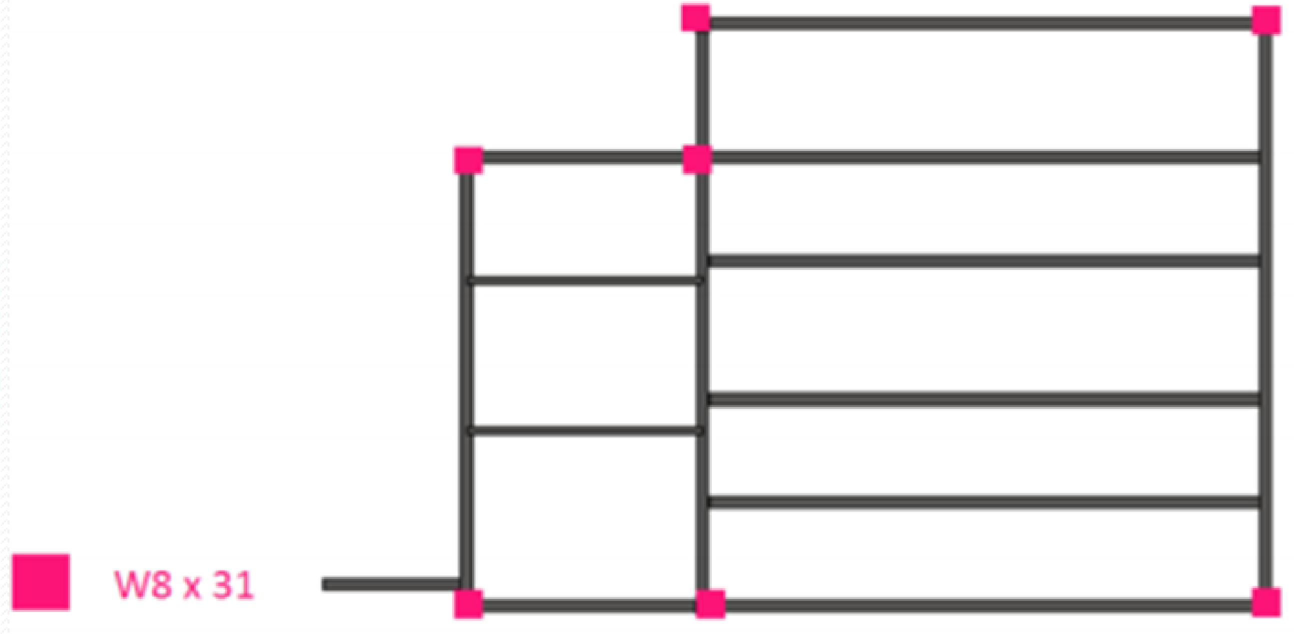
Structural Design: Family Raft and Tube Slides





Loading Combinations :	
Dead Loads	Live Loads
Metal Decking- 2psf	Water- 62pcf
Concrete Cover-150pcf	Assembly Platform- 100psf
Fiberglass Slide- 10psf	

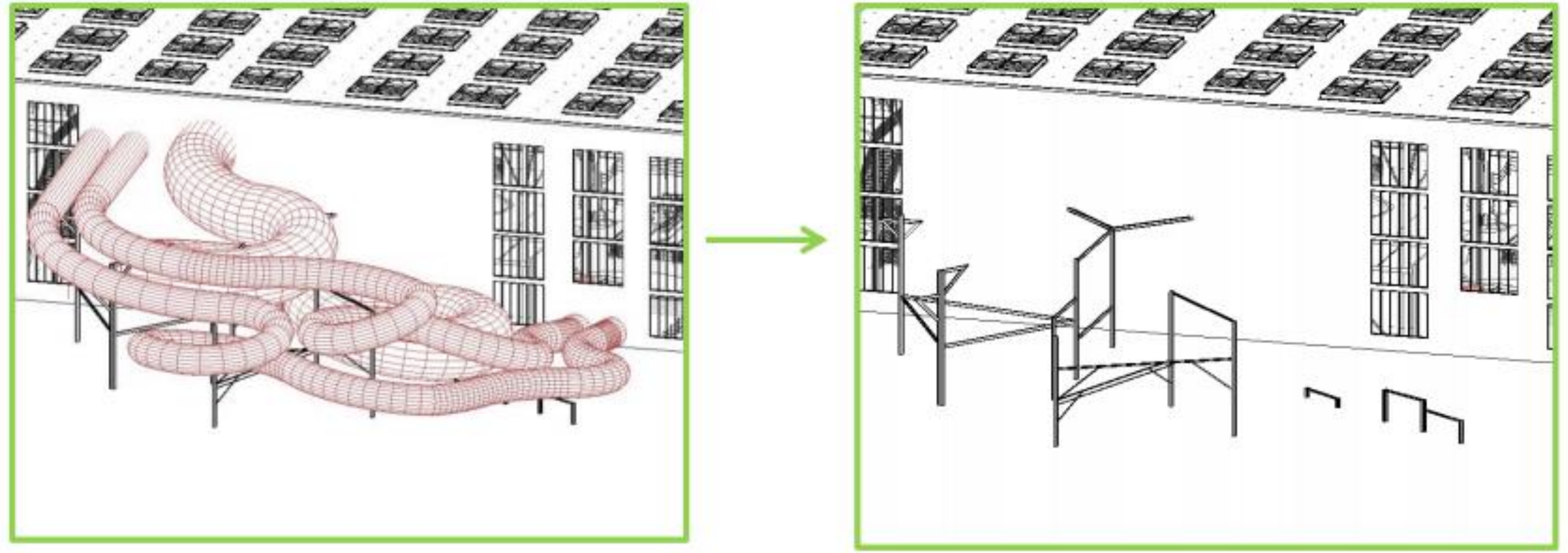


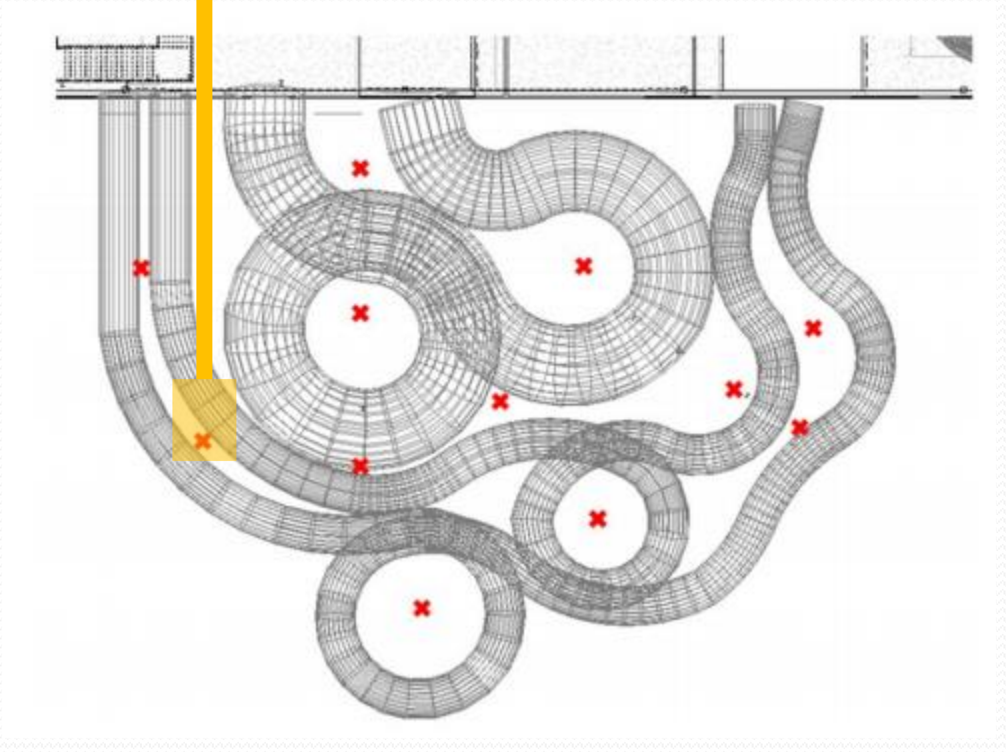


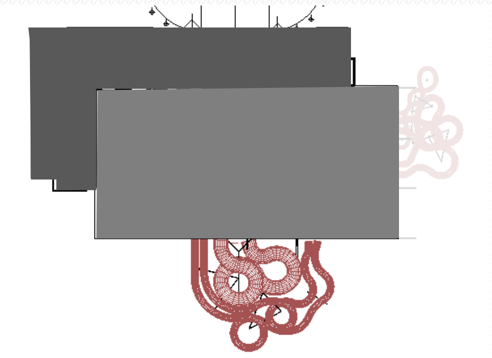
Structural Design: Family Raft and Tube Slides

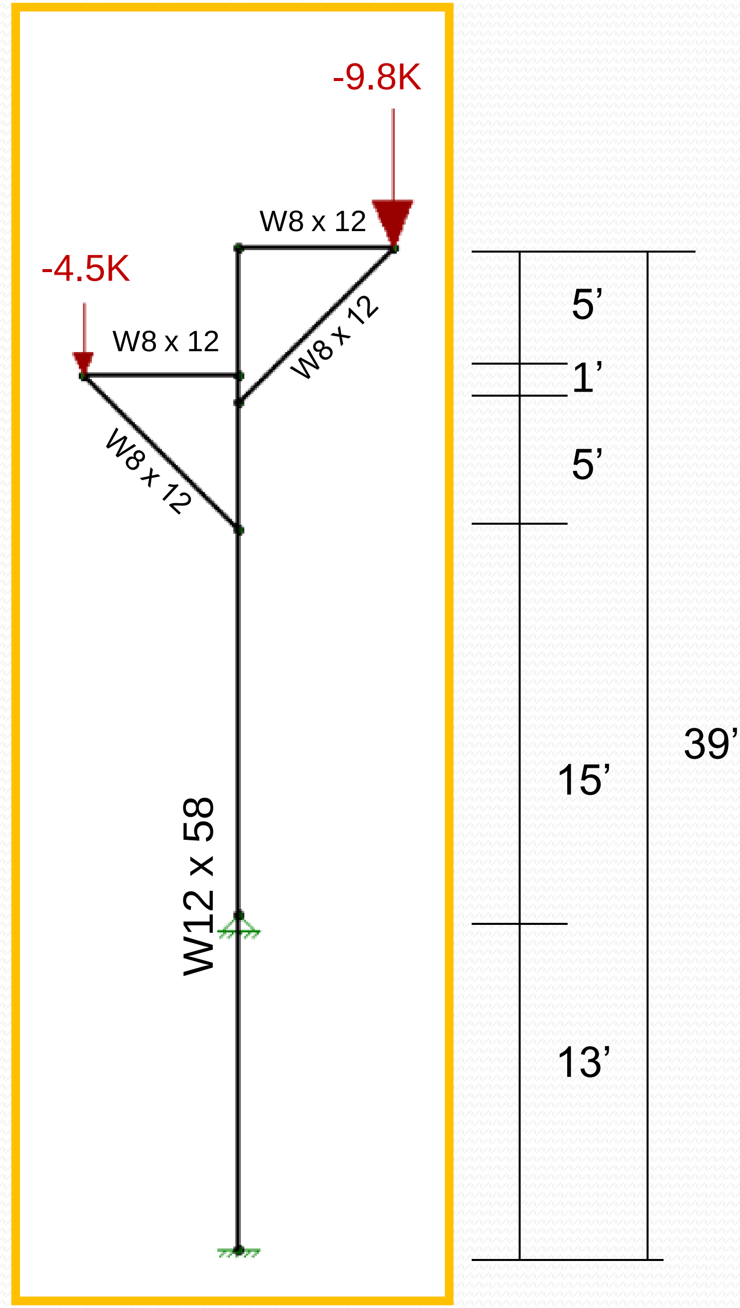
Loading Combinations:

- Designed with ASTM F2376-06 Loading Combinations
- Normal Building Codes Generally Do Not Apply
- Dead Load+ Rider Load + Water Load
- Wind Load Does Not Control (X1.4 Section 6)
- Assume Worst Case Scenario





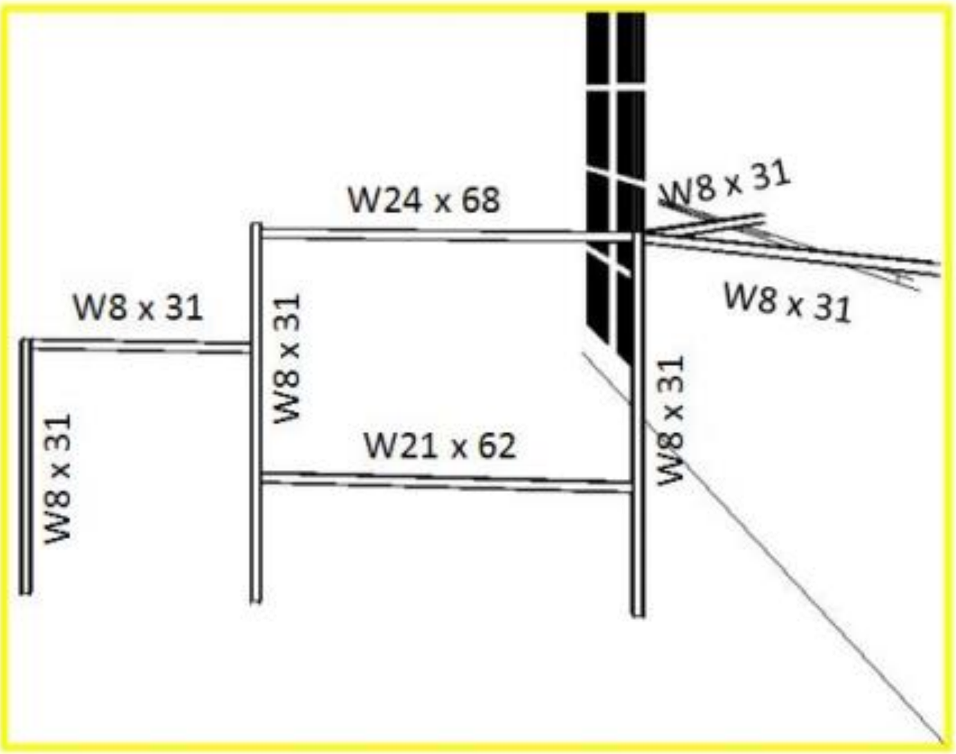


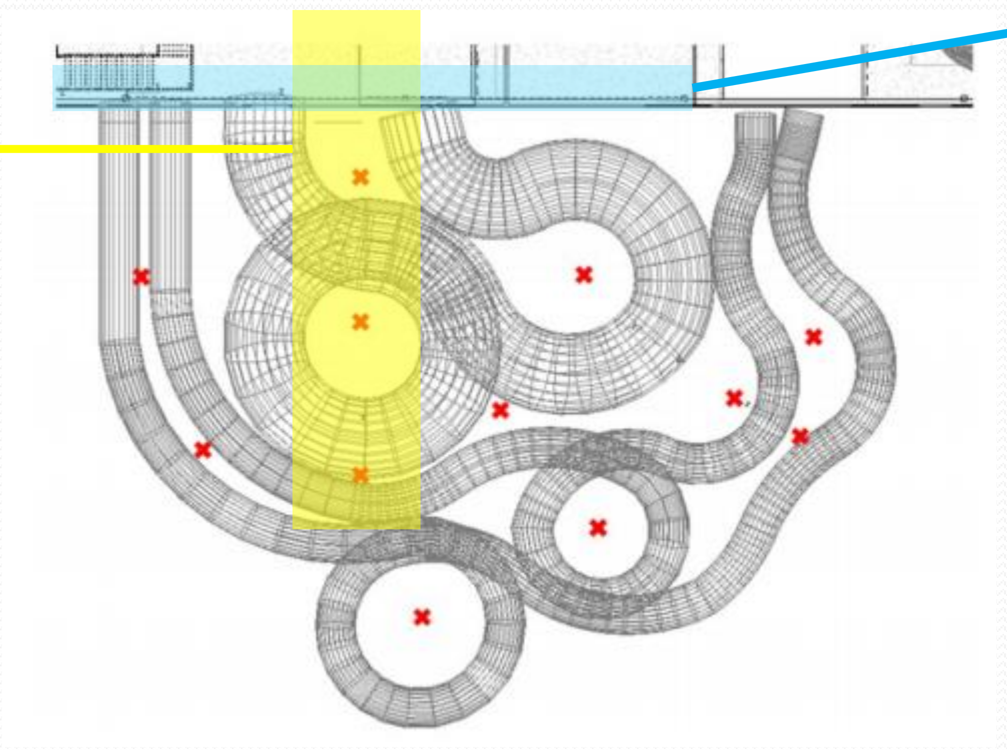


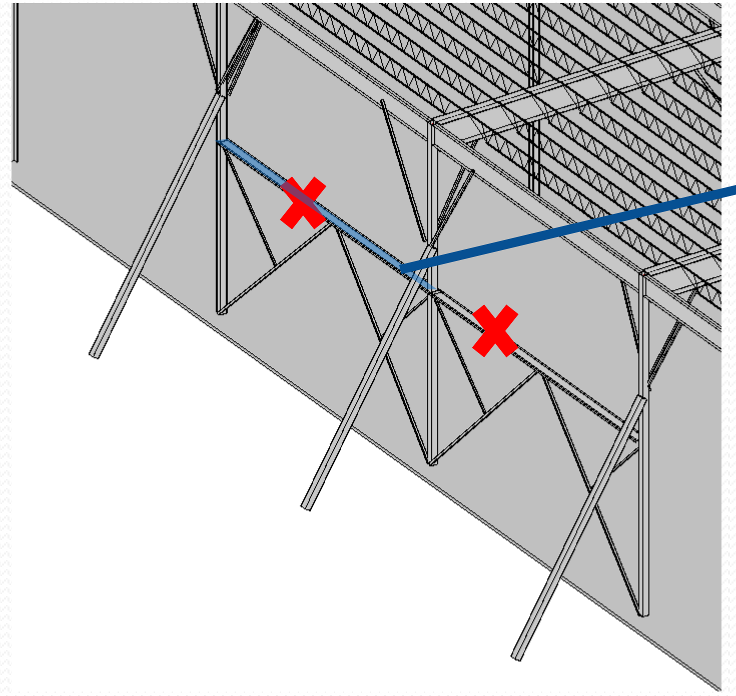
Loading Combinations
Two Riders Same Location
One Rider Left
One Rider Right
No Water Left/ Rider Right
Rider Left / No Water Right

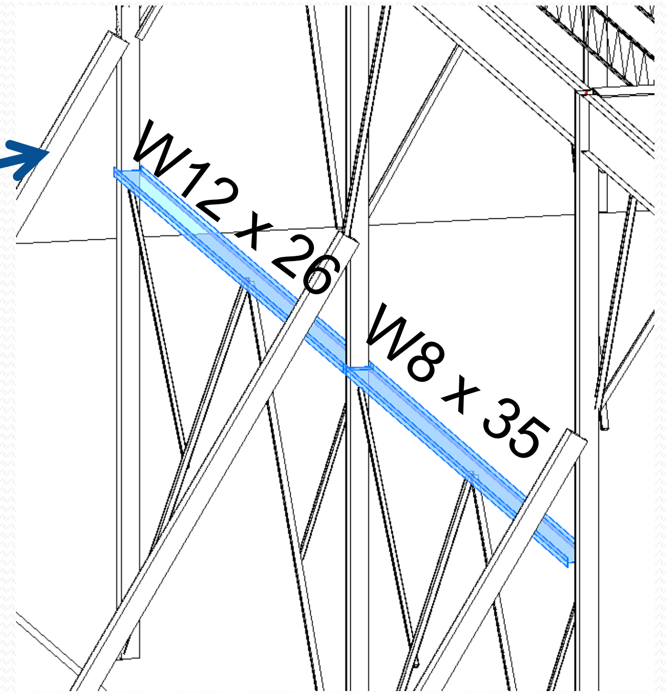
Structural Design: Family Raft and Tube Slides

- Higher Loads From 14' Diameter Family Raft
- Too Heavy for previous column design
- Designed a No-Sway Frame

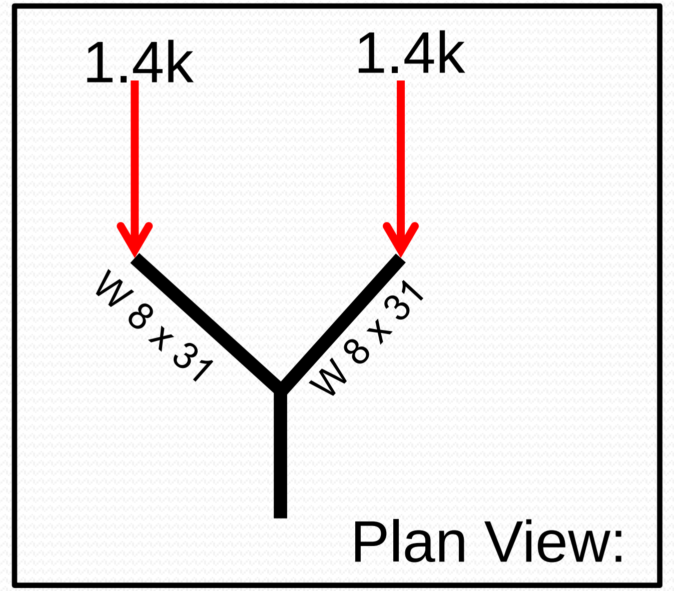








- W8x31 designed as tension members/ checked for compression
- WS Structure Applies a 1.4 K load to tie back



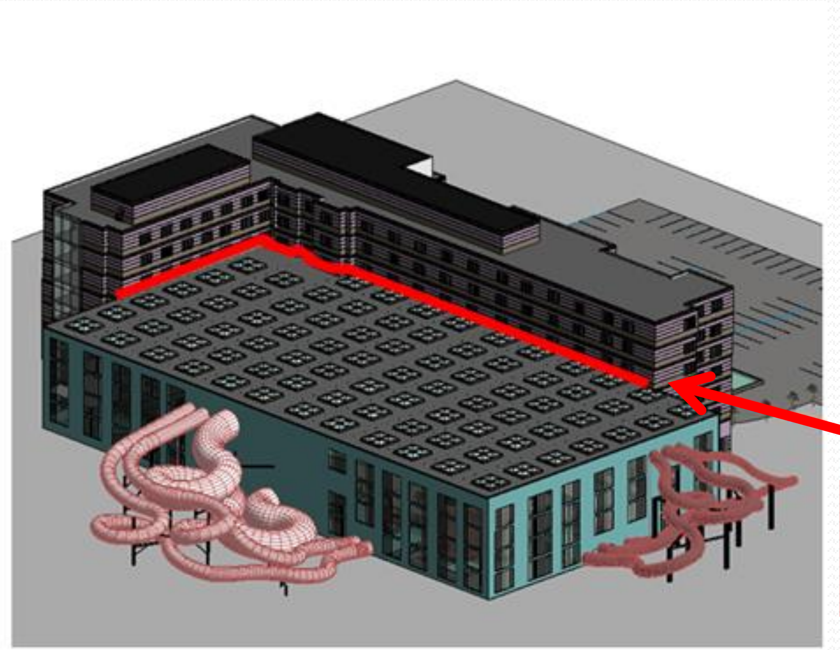
Structural Design: Water Park
Gravity System

Roof Conditions:

Expansion Joint:

Sized off of Max Deflections of both structures the 5th floor.

2.5” Roof to Wall System



Built Up Roof:

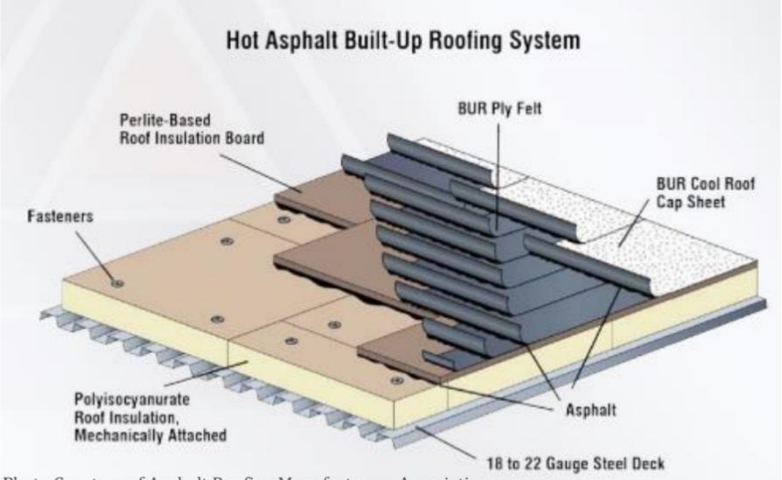
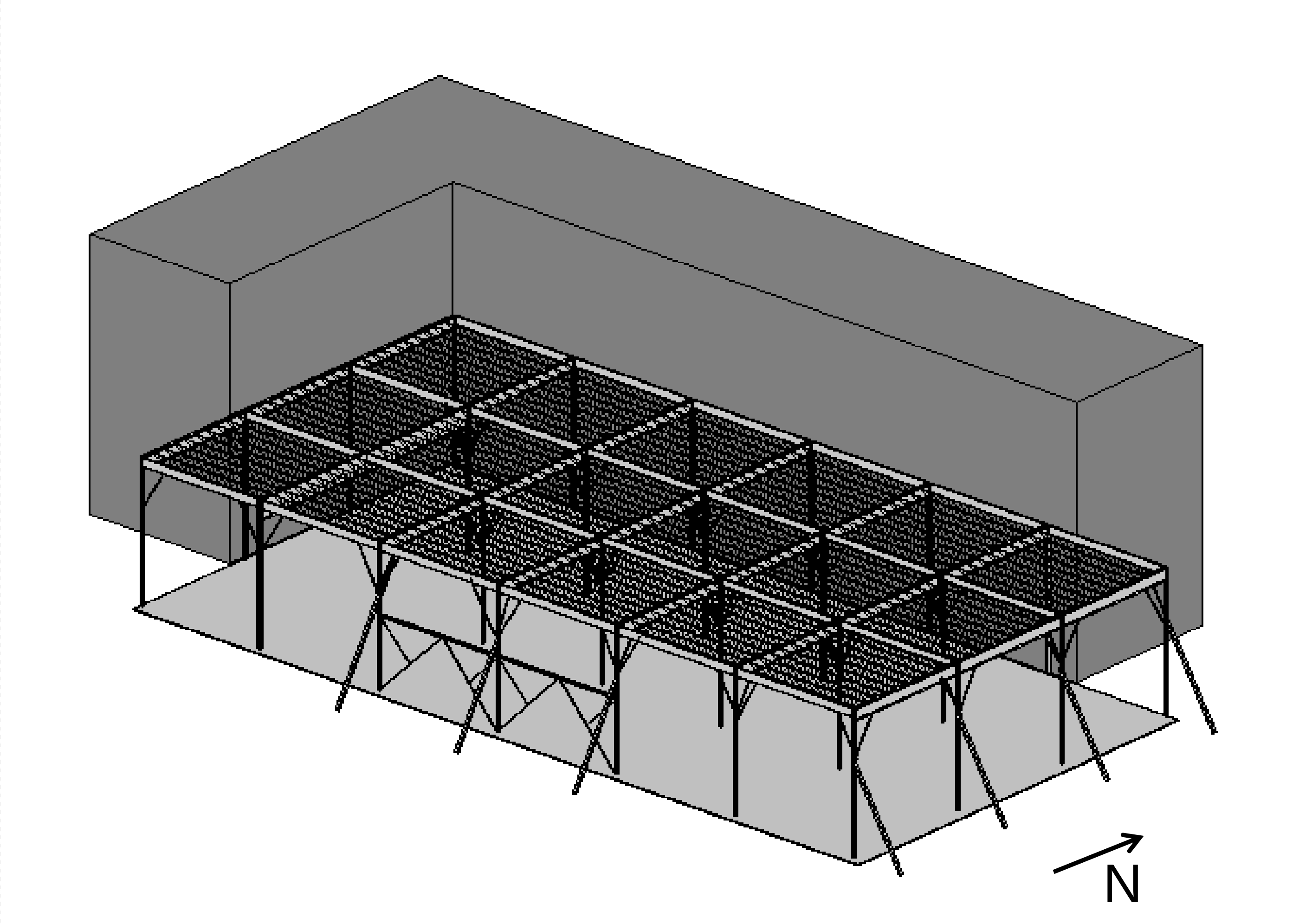
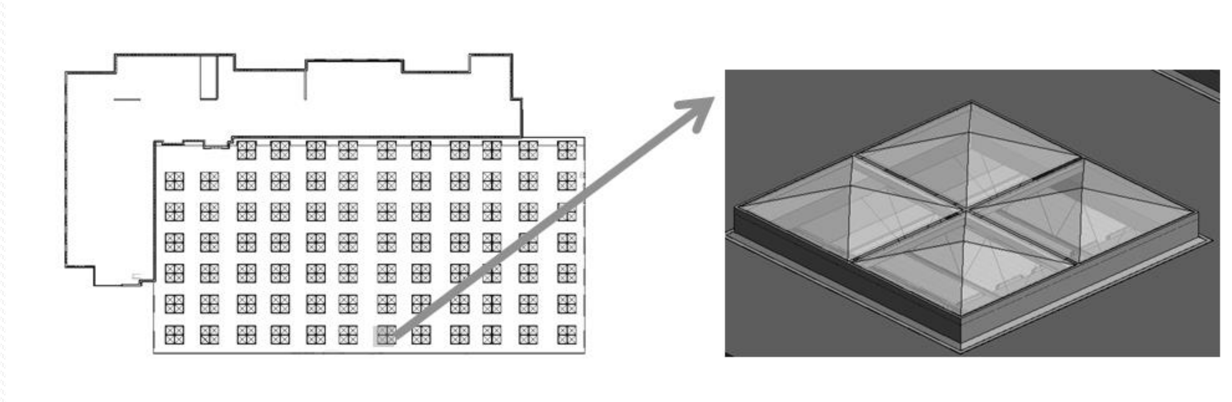


Photo Courtesy of Asphalt Roofing Manufacturers Association



Skylights:



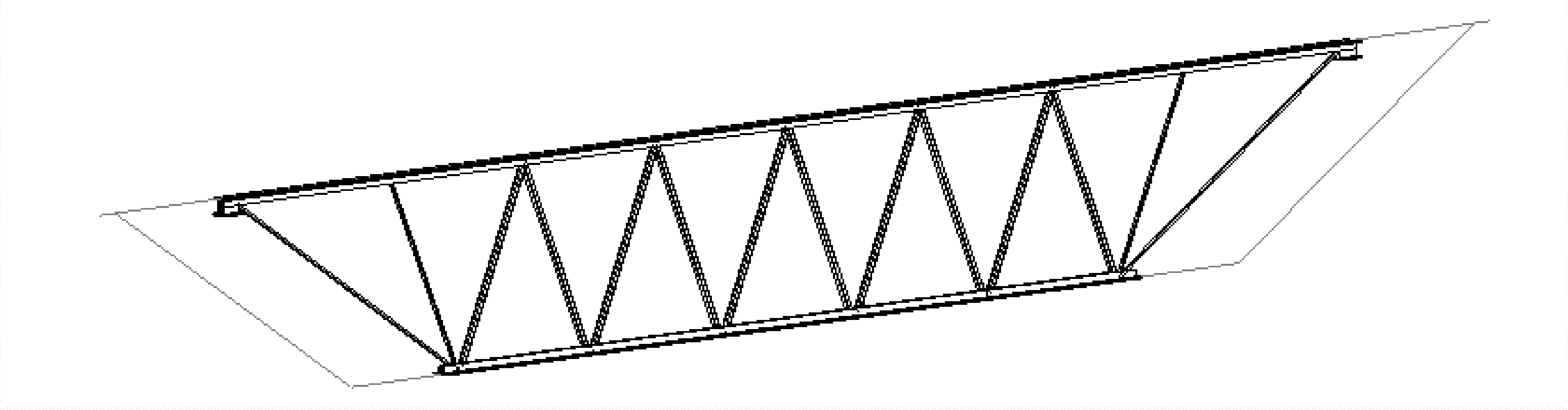
Loading Conditions:

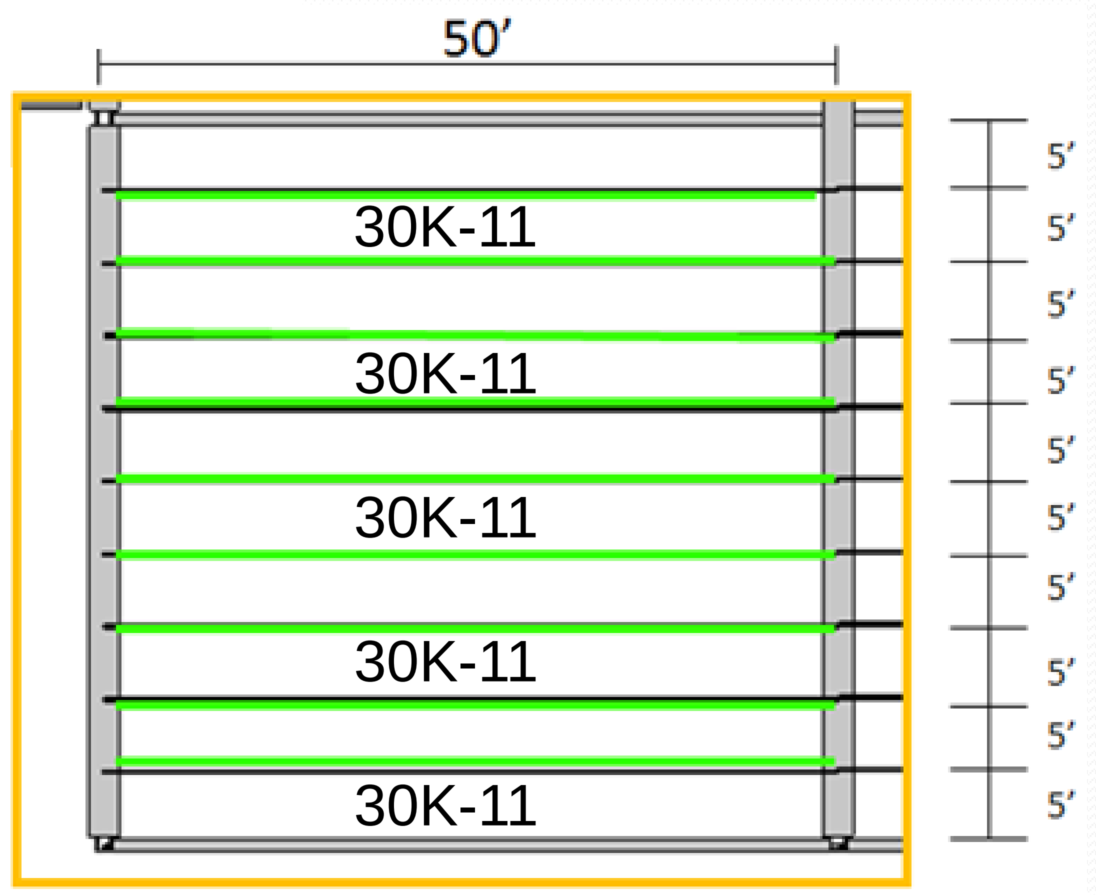
Metal Decking- 2psf
Rigid Insulation- 2 psf
Built Up Roof- 20psf
HVAC/ MISC -12psf
Skylights- 6psf
Ordinary flat roof live – 20 psf
Snow Flat Projection- 22 psf

Structural Design: Water Park Gravity System

Joist Design:

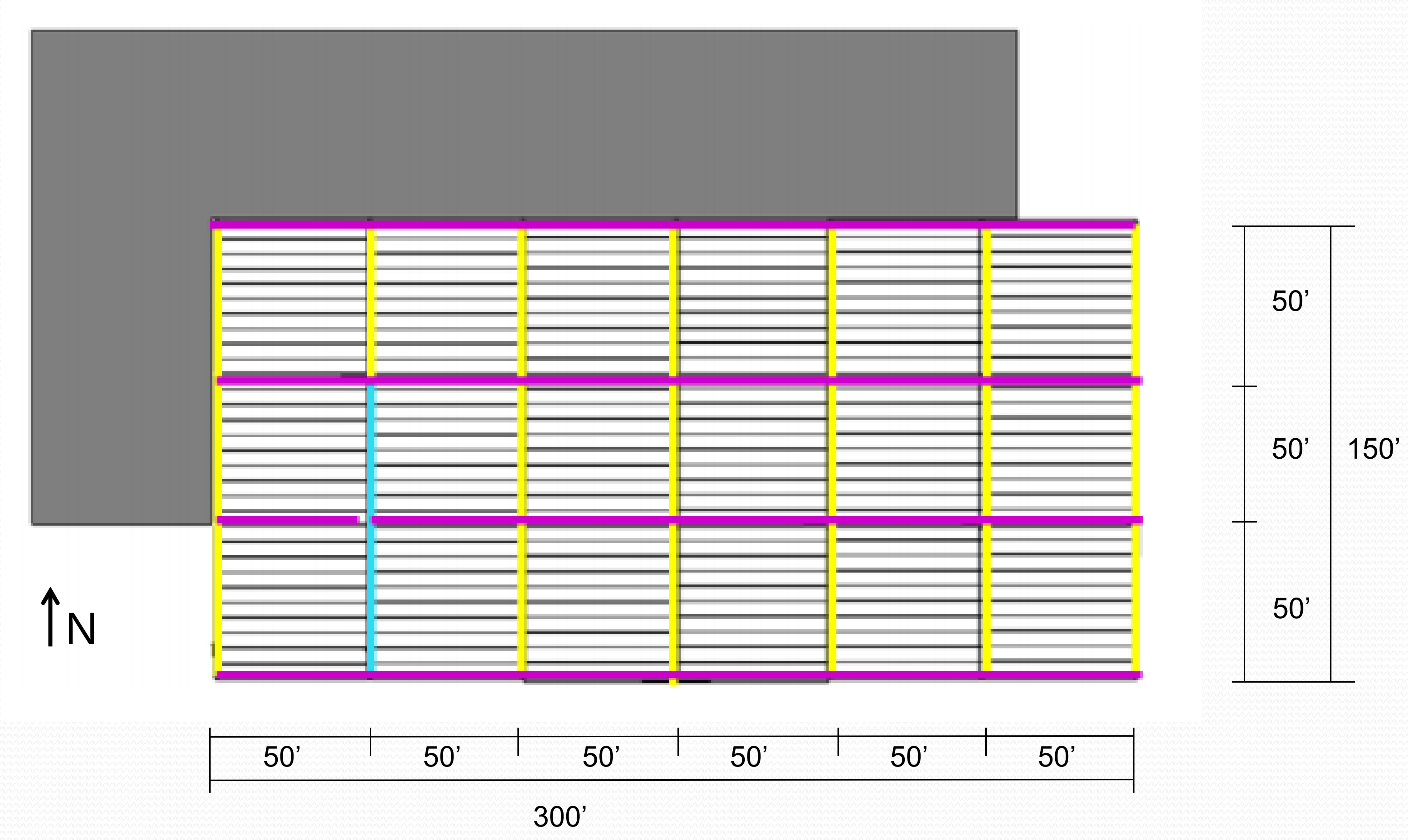
- Economy K-Series Tables Were Used
- 50 Foot Spans
- Trib Width 5 Feet
- No Depth Constraints

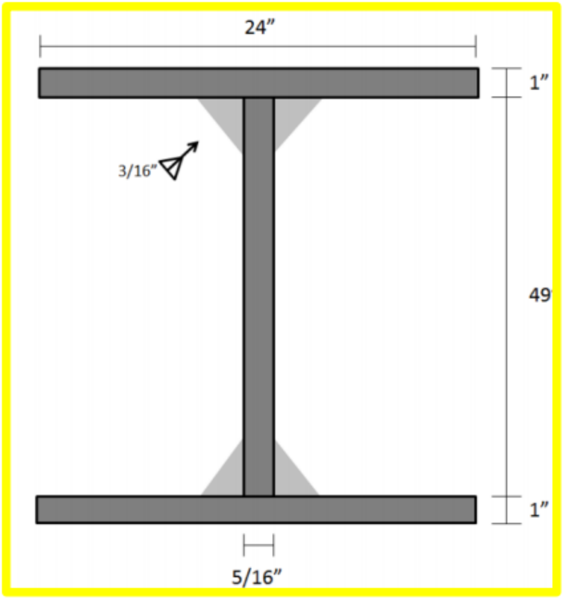


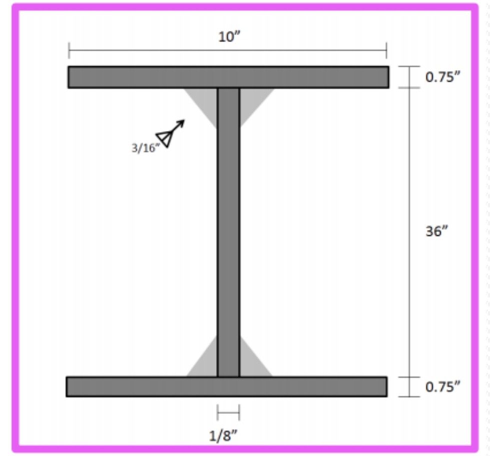


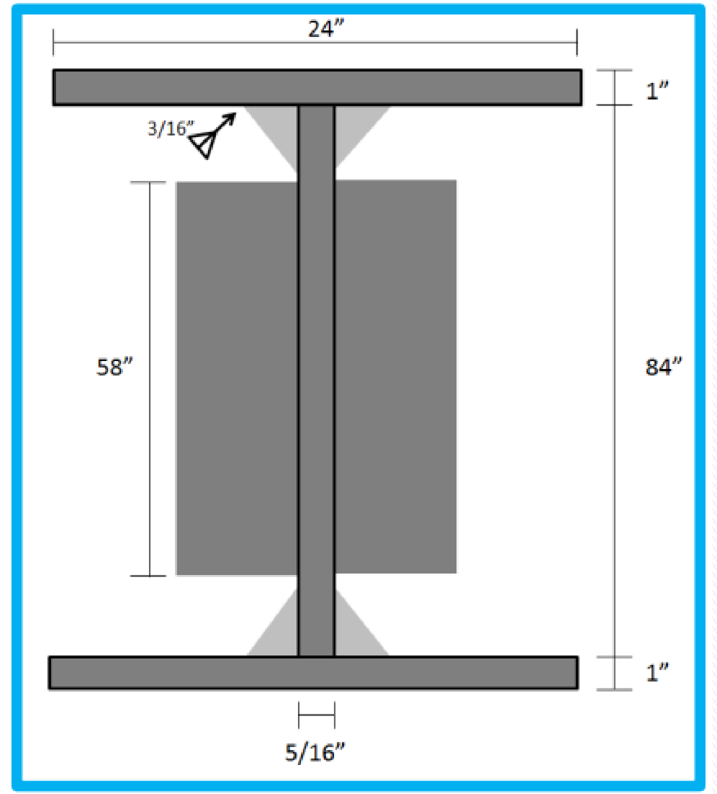
Structural Design: Water Park Gravity System

Plate Girder Layout









Designed By:

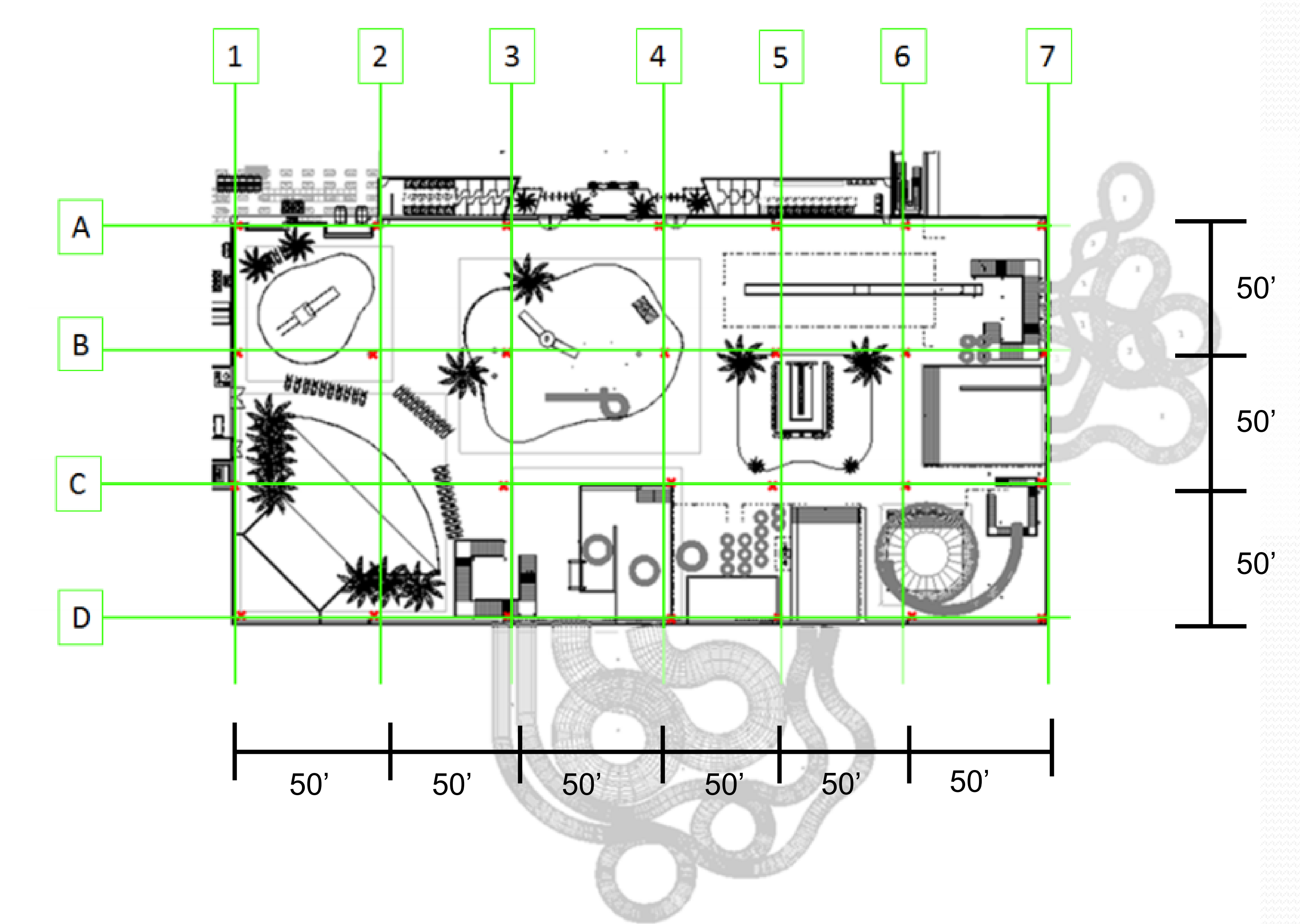
- Depth of beam (Guess and Check)

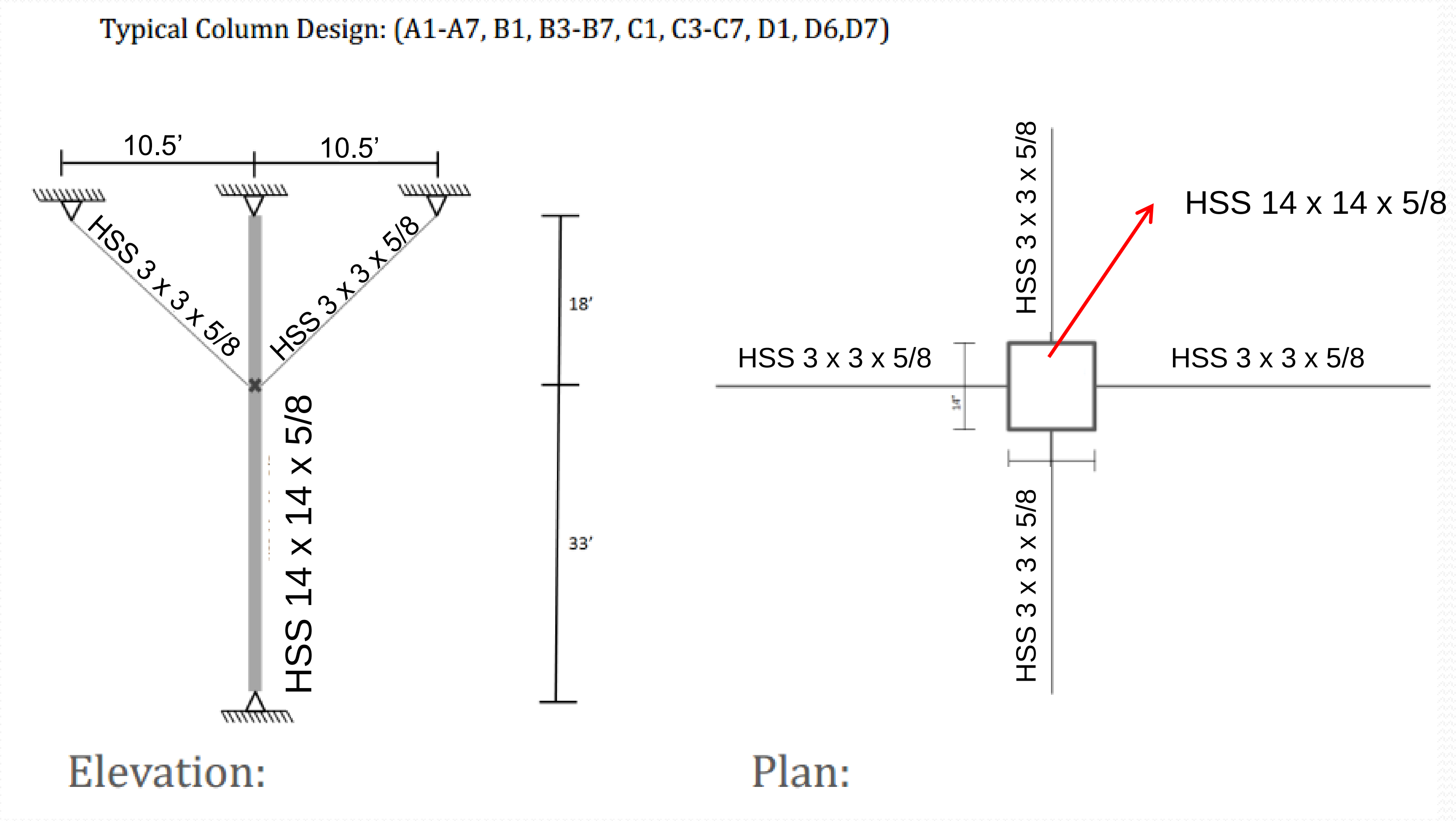
  L/D= 10 to 12

- Checked for a Slender Web
- Checked for Shear Strength
- Weld Shear Flow was compared to shear yielding and shear rupture.

Structural Design: Water Park Gravity System

Column Layout



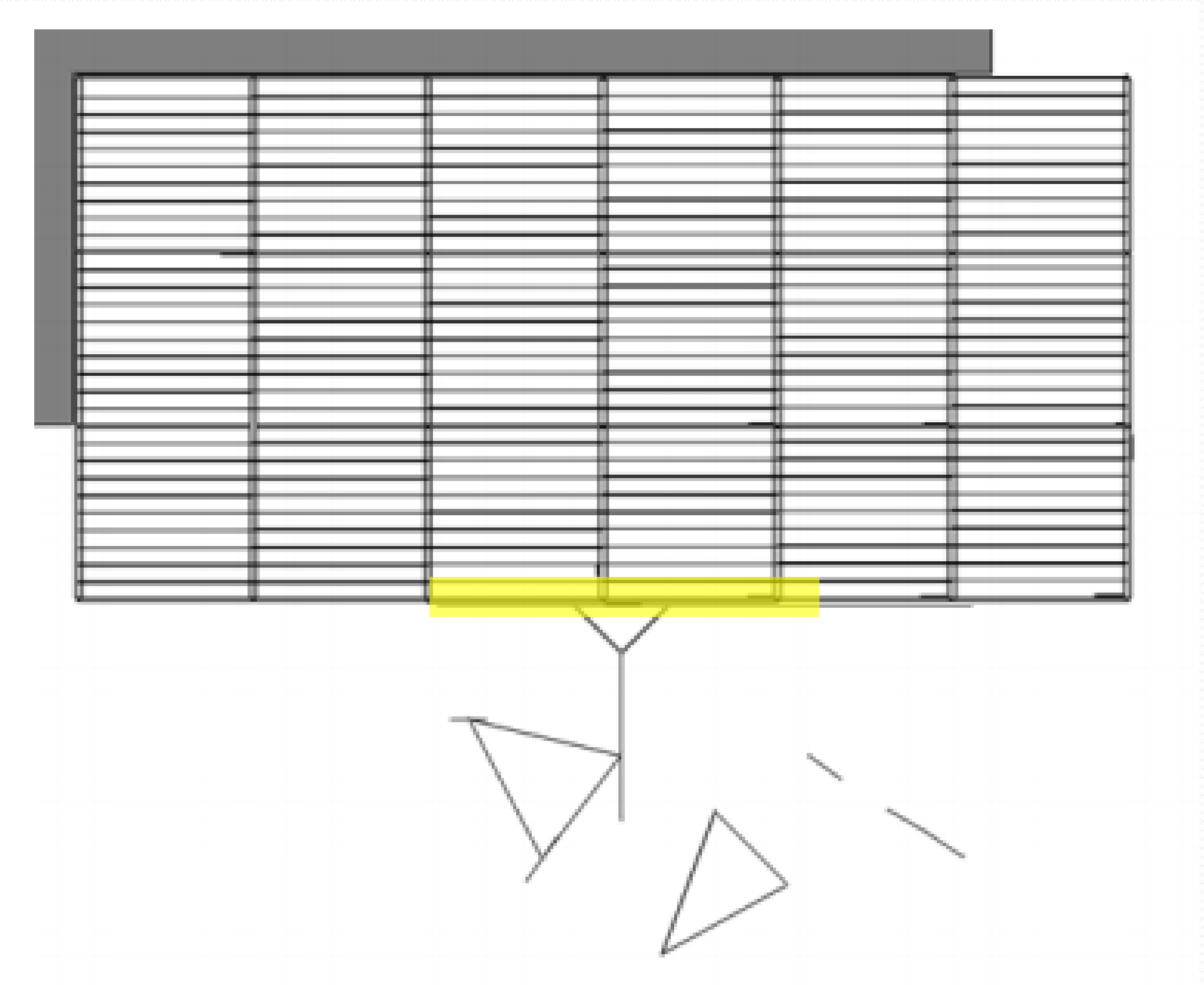


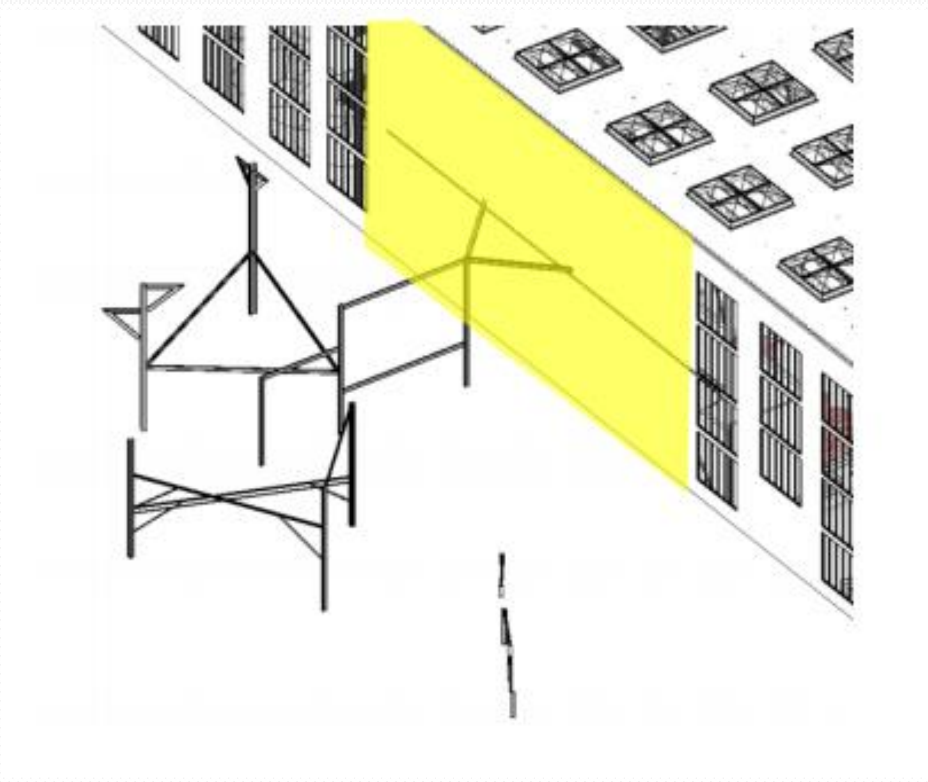
Column Concerns

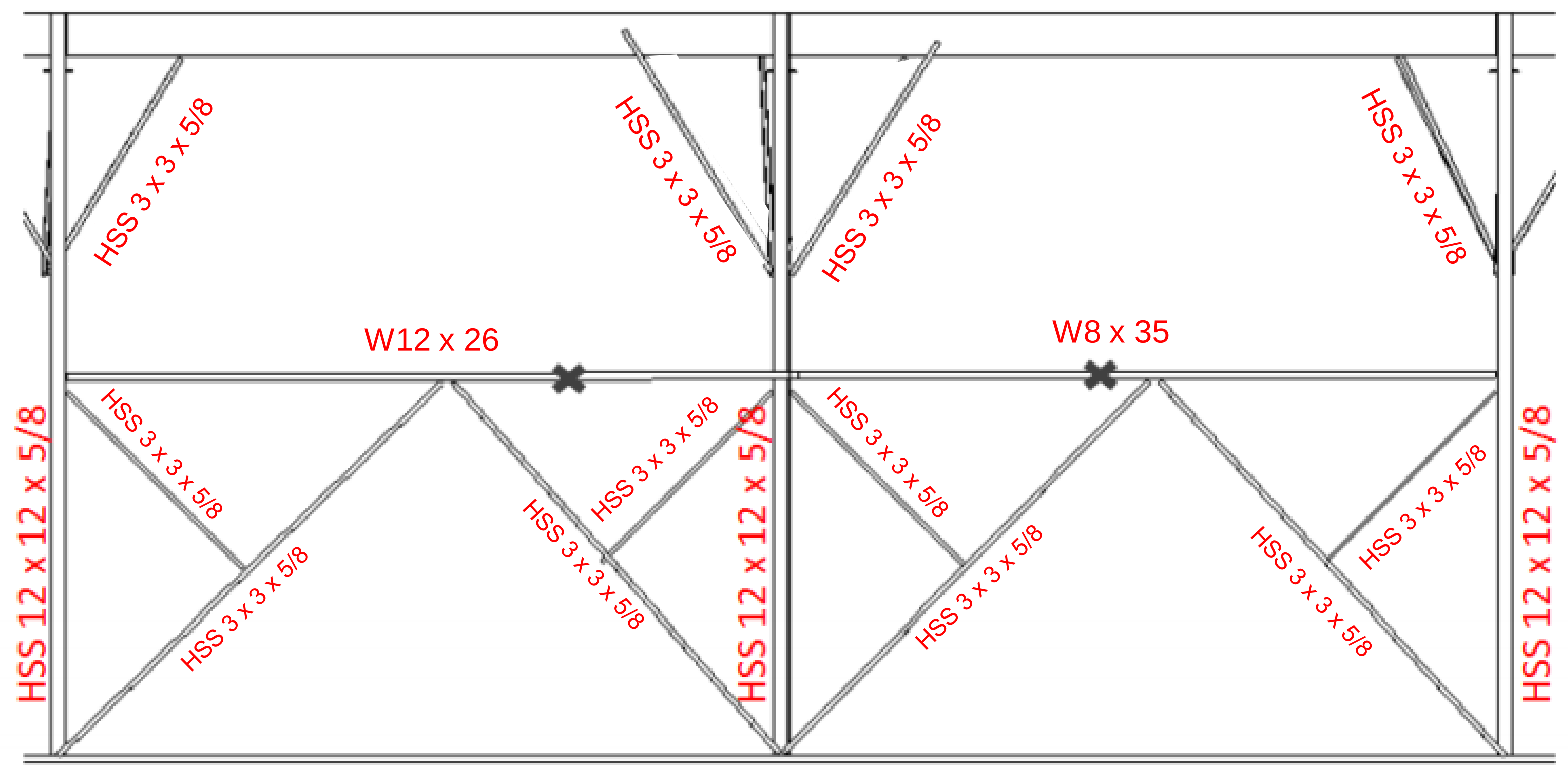
- Open Layout Concept
- Large Unbraced Length → Relative Column Bracing Designed
- Mold Growth From High Traffic → HSS Hollow Structural Members Used
- Erosion From Chlorine → Epoxy Coating Used

Structural Design: Water Park
Gravity System

Water Slide Tie Back System

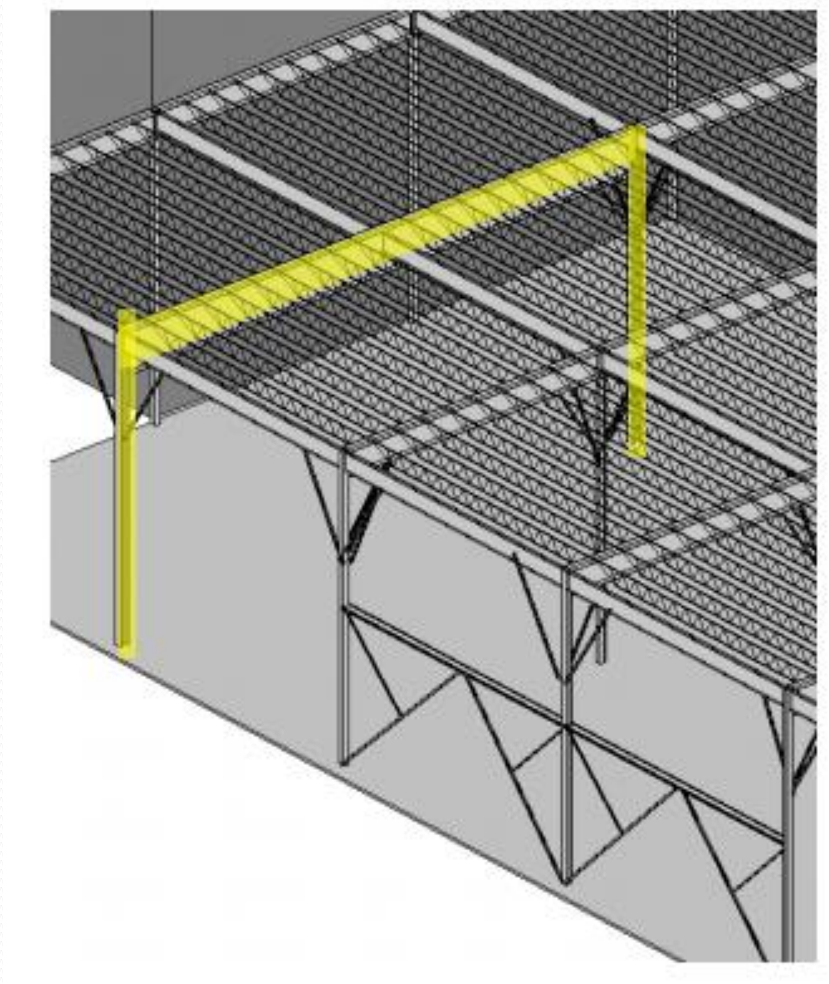


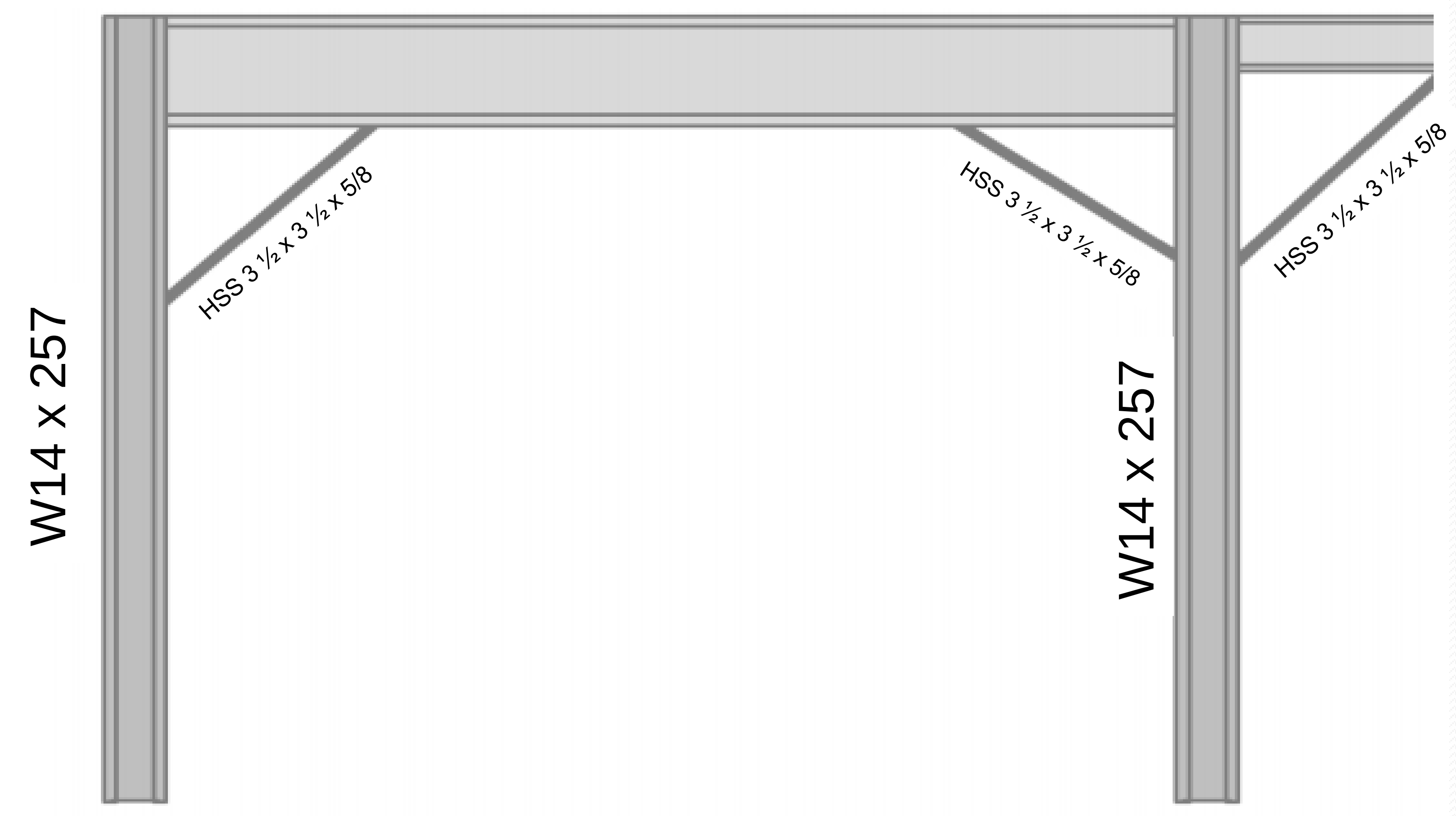




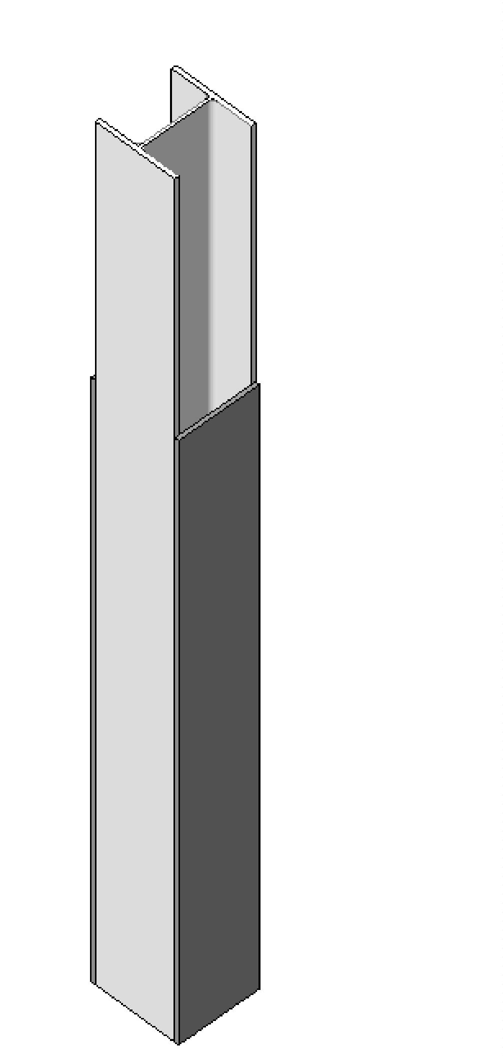
Structural Design: Water Park Gravity System

100 Foot Span Bay





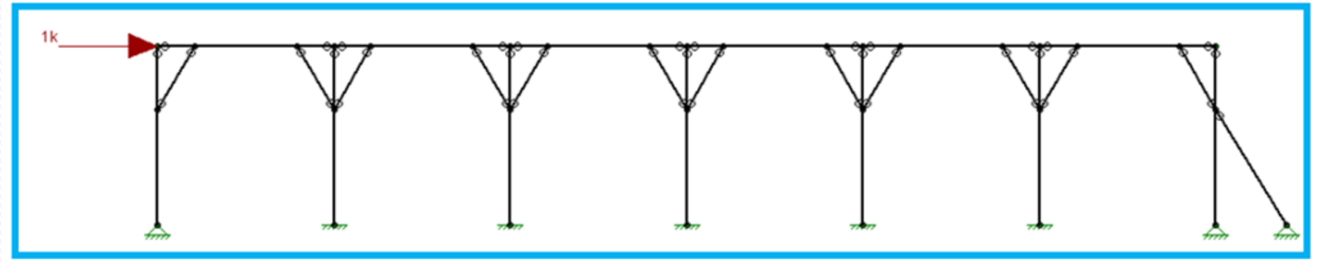
Wide-Flange Cover



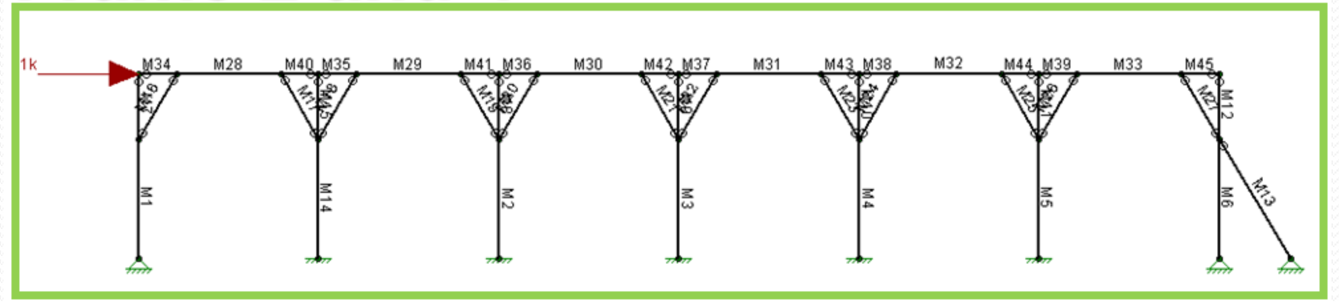
- Two Wide Flange Columns Detailed
- Fabricated Before Installation
- Mimic HSS
- Minimize Mold Growth

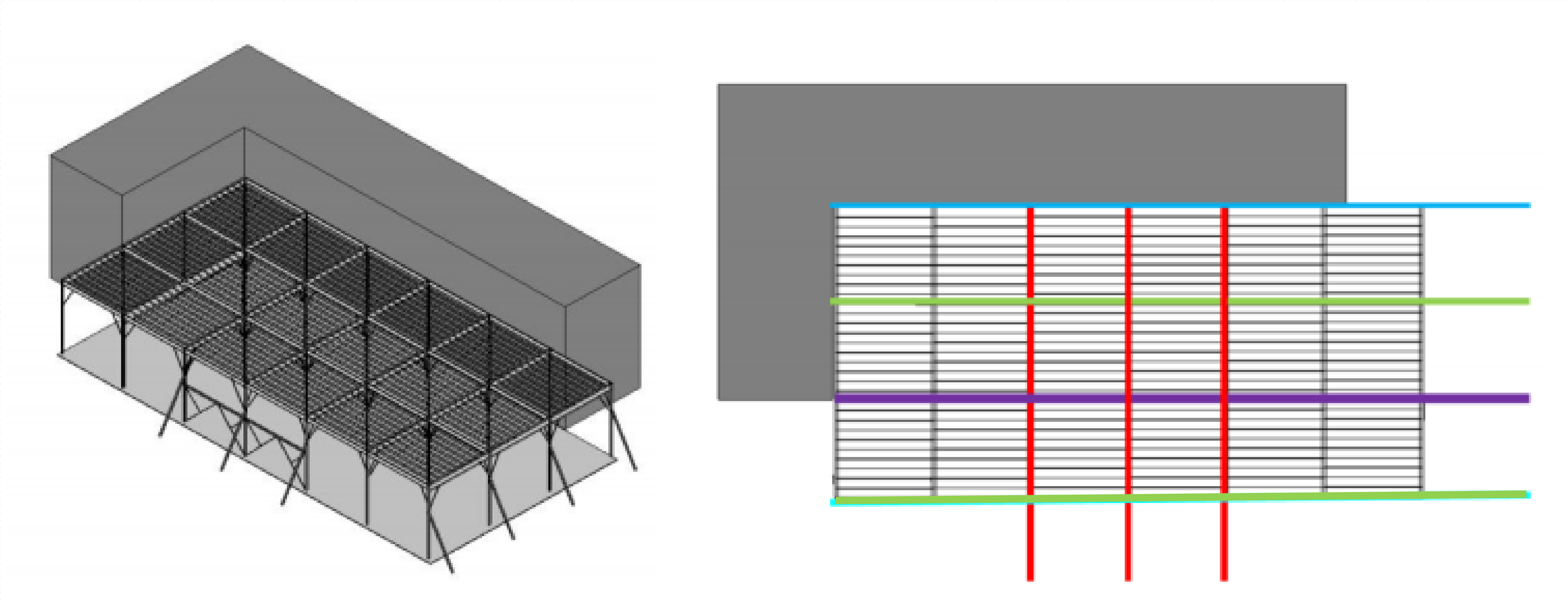
Structural Design: Water Park
Lateral System

Frame 1

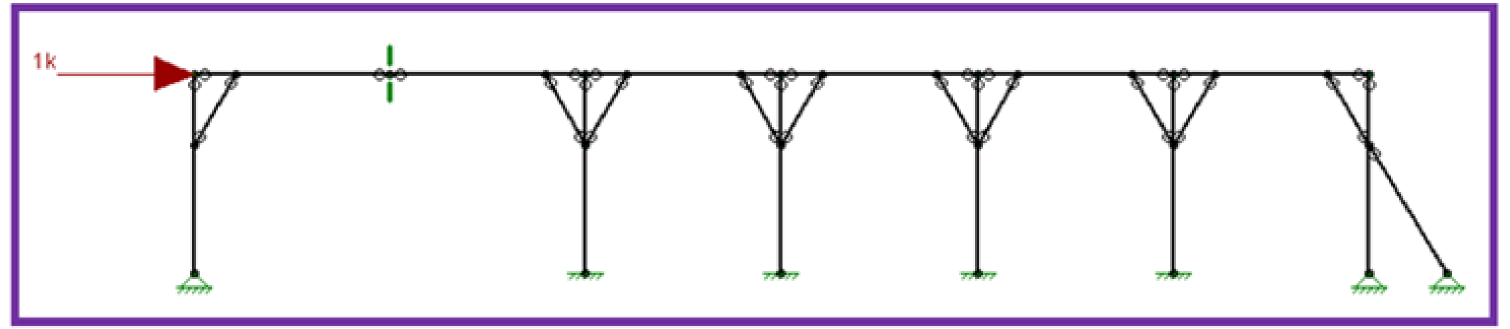


Frame 2 and 4

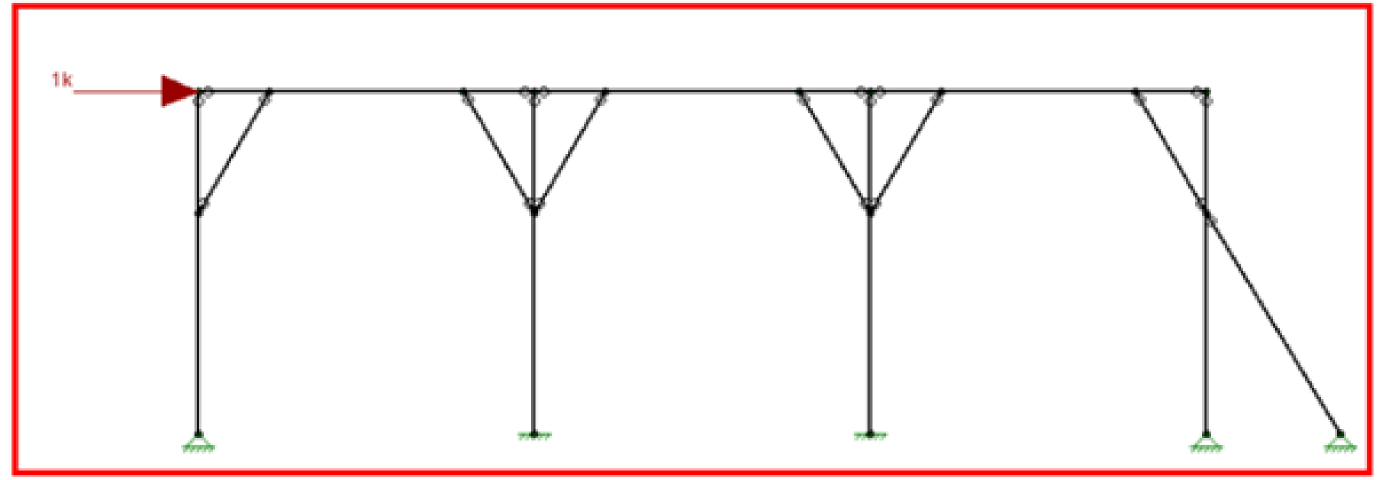




Frame 3

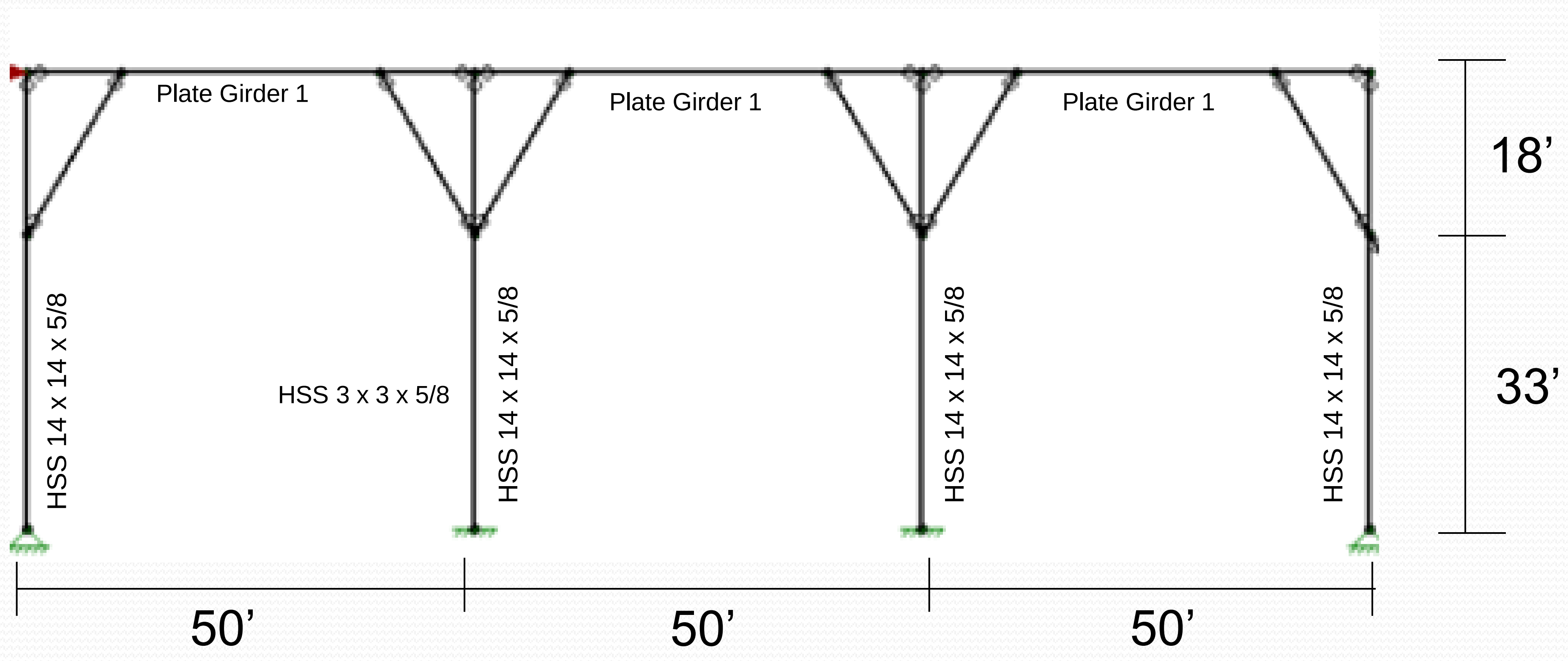


Frame 5

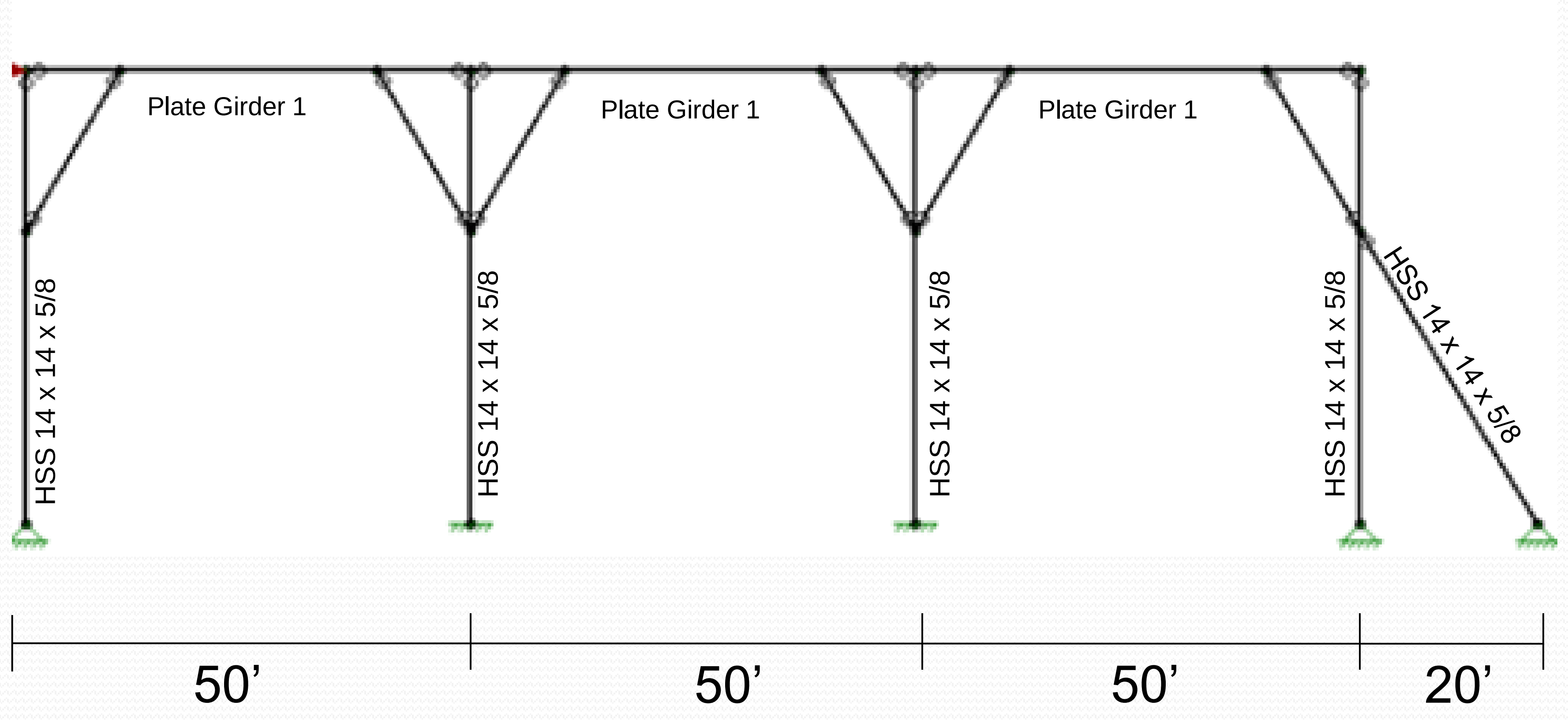


Structural Design: Water Park
Lateral System

Original Frame 5:

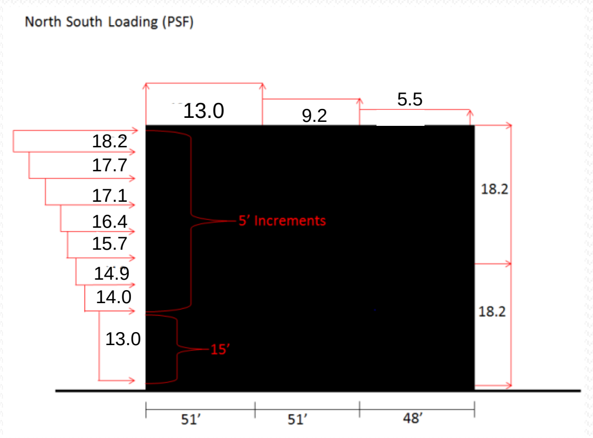


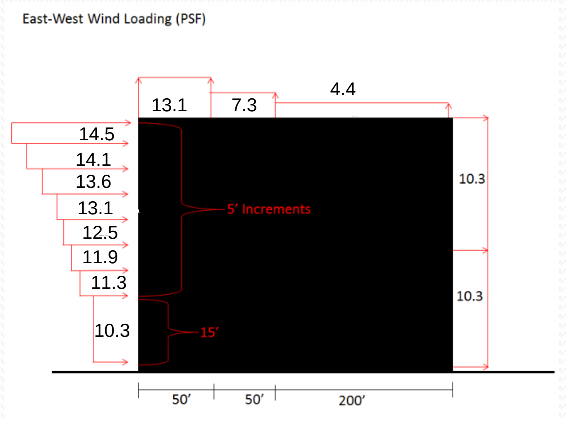
- ○ Low Stiffness
- ○ High Deflection
- • Problem Members: Unbraced Portion of Columns

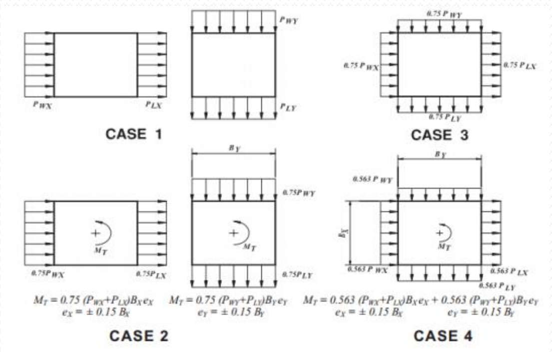


Structural Design: Water Park Lateral System

Wind Loading ASCE 7-10

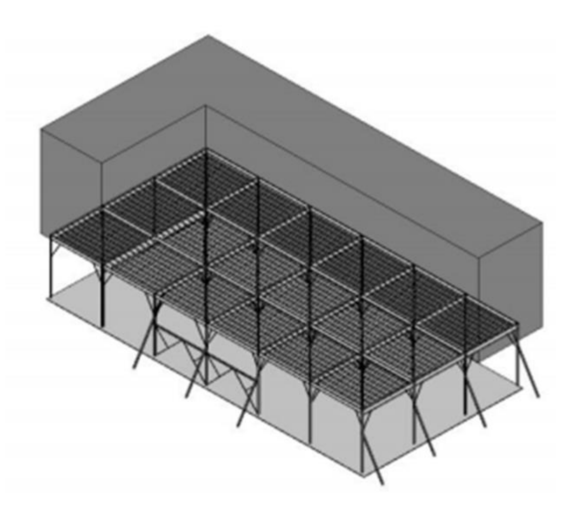


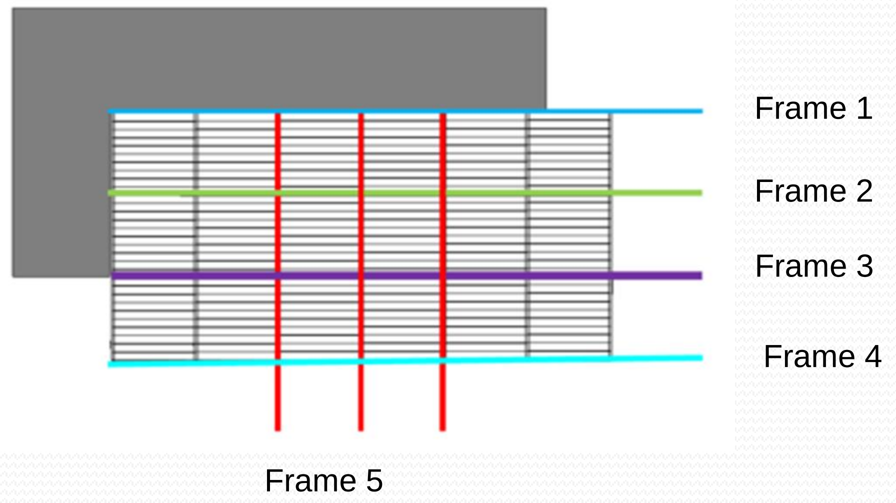




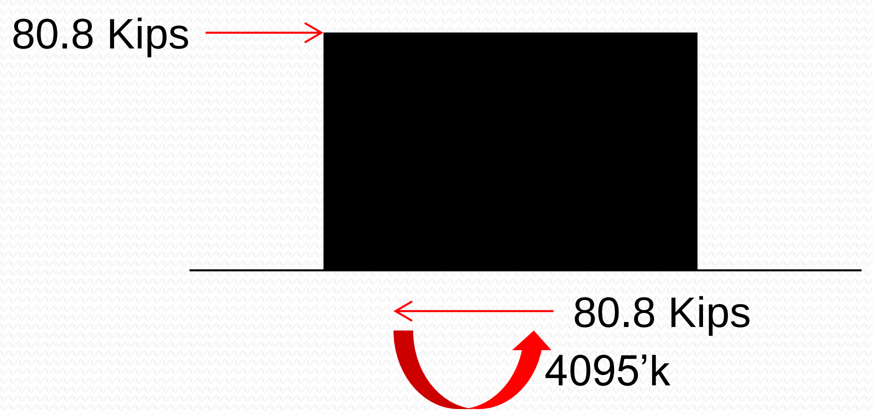
Frame Deflection Due to Wind Loading Cases:

Loading Case	Frame With Largest Deflection	Max Δ (In)	Max Allowable Δ (H/400)	Pass?
Case 1	Frame 5	0.70	1.53	Yes
Case 2	Frame 2	1.51	1.53	Yes
Case 3	Frame 5	0.4	1.53	Yes
Case 4	Frame 5	1.01	1.53	Yes





Seismic Loading ASCE 7-10



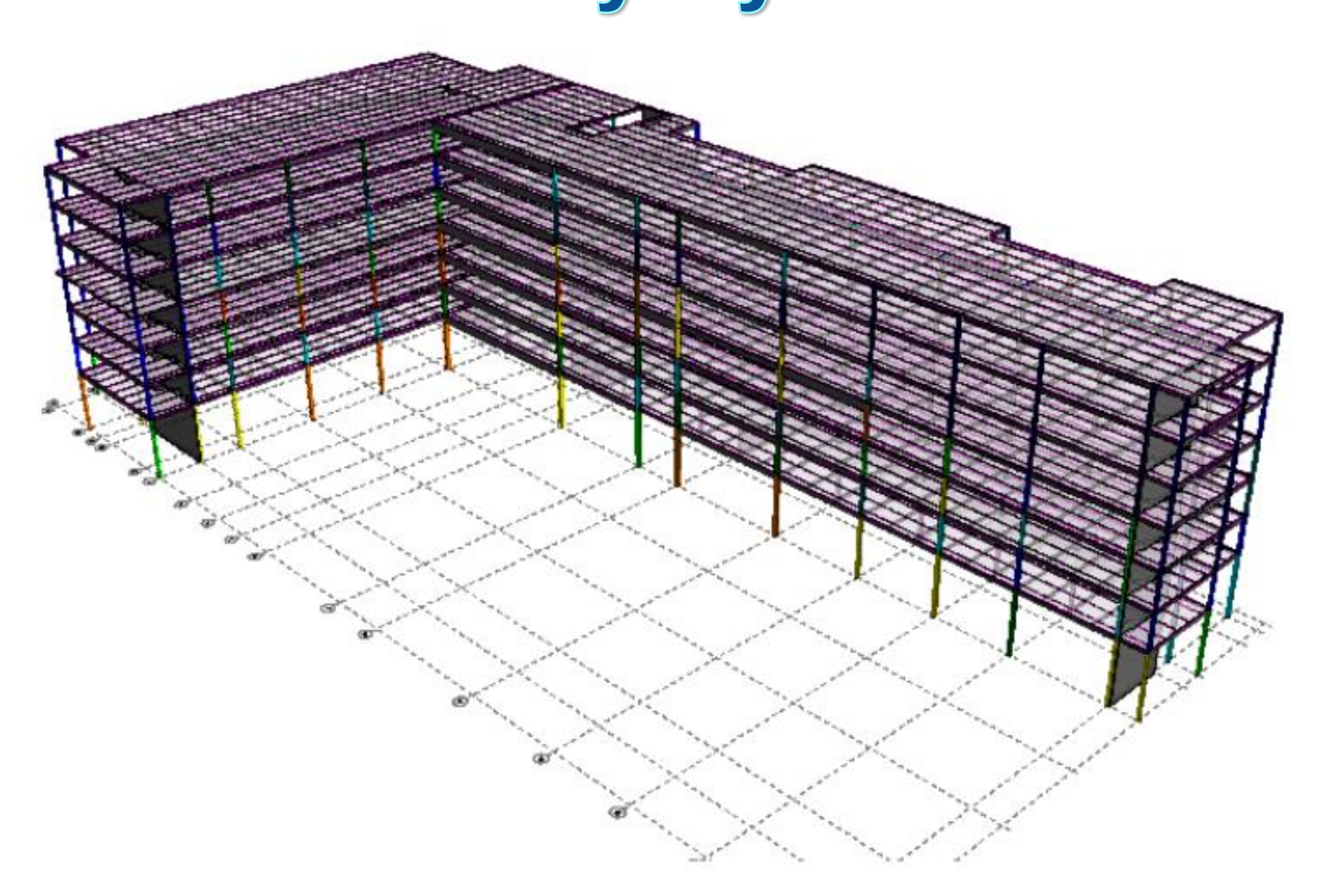
Frame Deflection Due to Seismic Loading:

Loading Case	Frame With Largest Deflection	Max Δ	Allowable Deflection (in)	Pass?
Seismic	Frame 2	1.06	1.53	Yes

Structural Design: Hotel Gravity System

New Gravity Live Loads

Occupancy	Live Load (psf)	Partition (psf)	Total Load (psf)	Reducible?
Arcade	75	10	85	Yes
Bar	100	10	110	Yes
Bathroom	100	0	100	Yes
Corridor	100	0	100	No
Corridor(Above 1st Floor)	70	0	70	No
Hotel Room	40	0	40	Yes
Hospital	40	10	50	Yes
Lobby-Assembly Room	100	0	100	Yes
Mechanical Space	150	0	150	No
Office	50	10	60	Yes
Retail	100	10	110	Yes
Roof	20	0	20	No



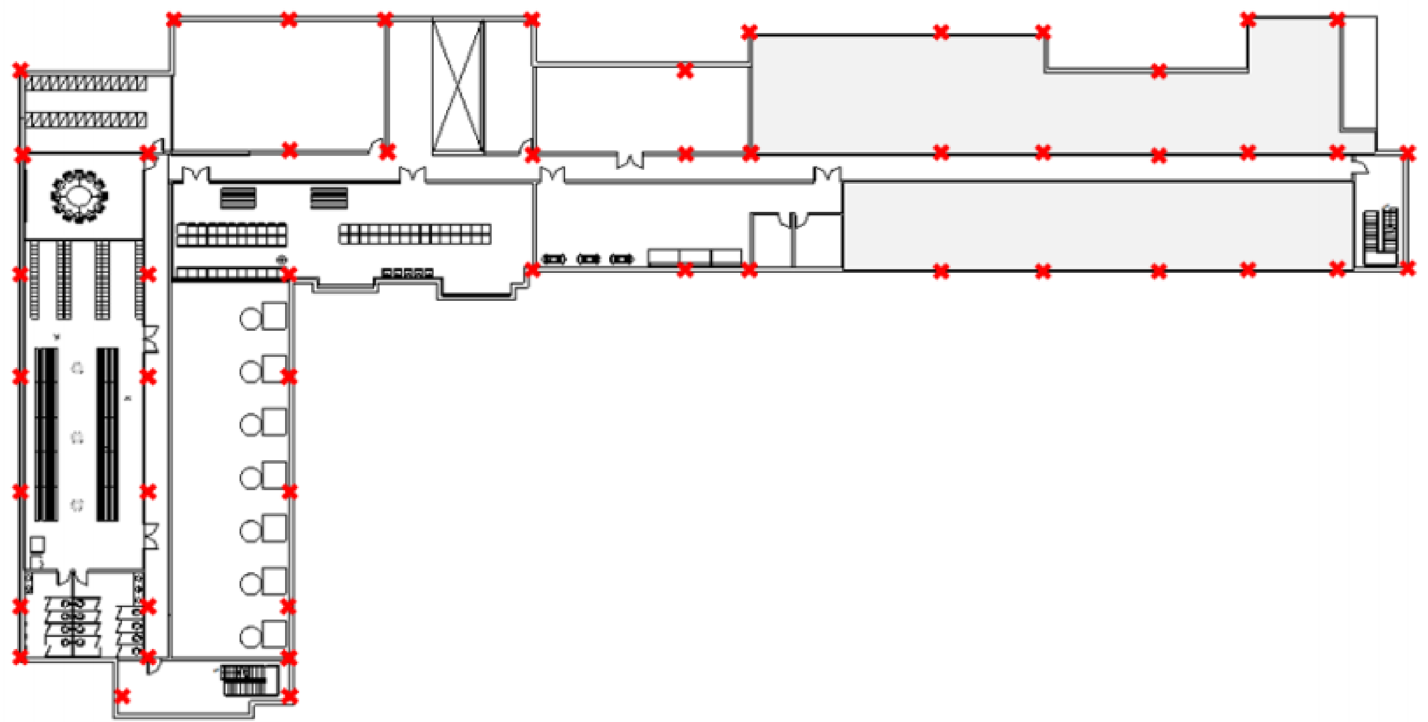
Composite Decking Instead of 2-Way Concrete Slabs :

- Superimposed Loading: 100psf
- 9 Foot Spans
- Normal Weight Concrete
- No- Shoring Needed
- Spray on Fireproofing Required

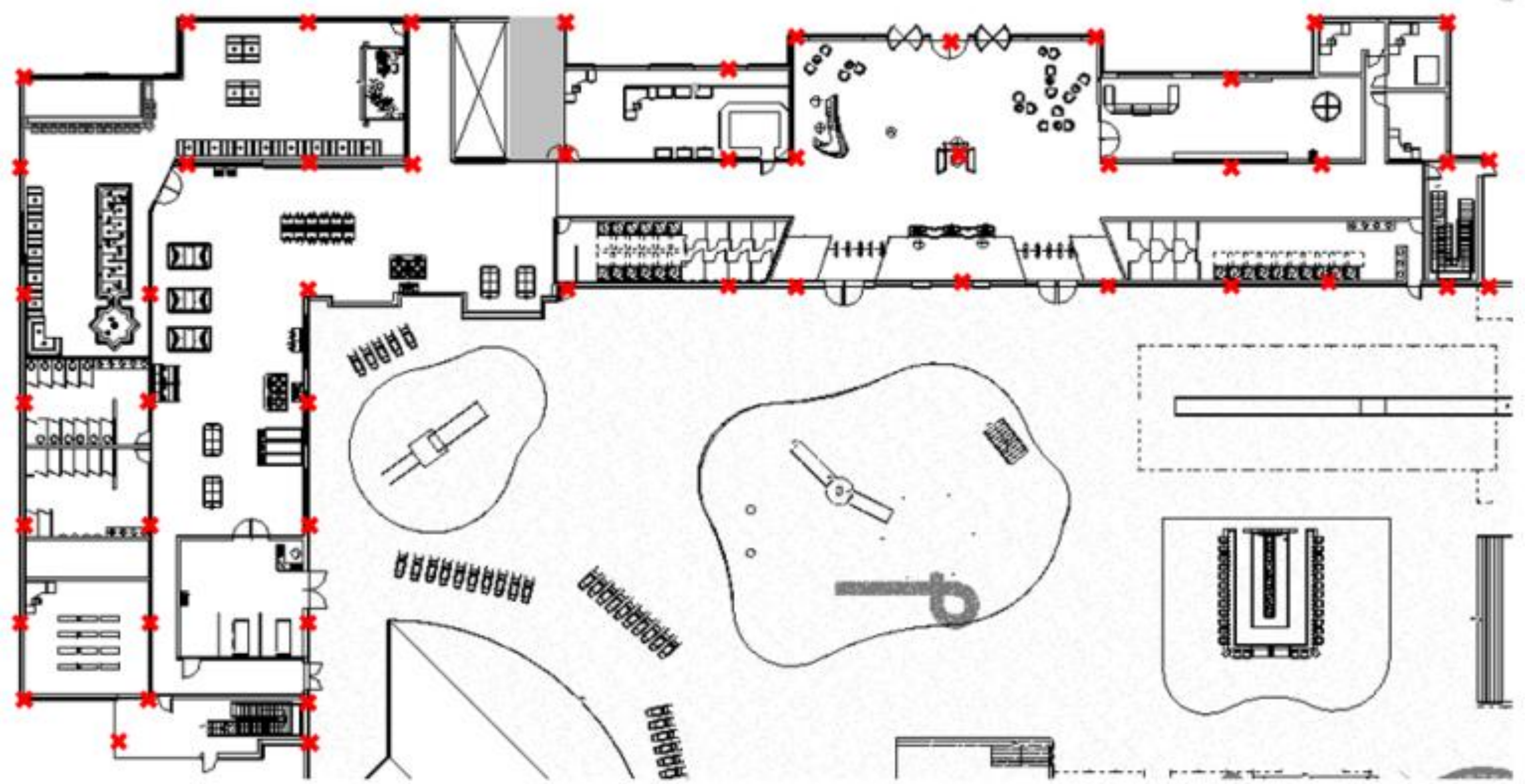
Designed Decking: Vulcraft 1.5VLR 20

Structural Design: Hotel
Gravity System

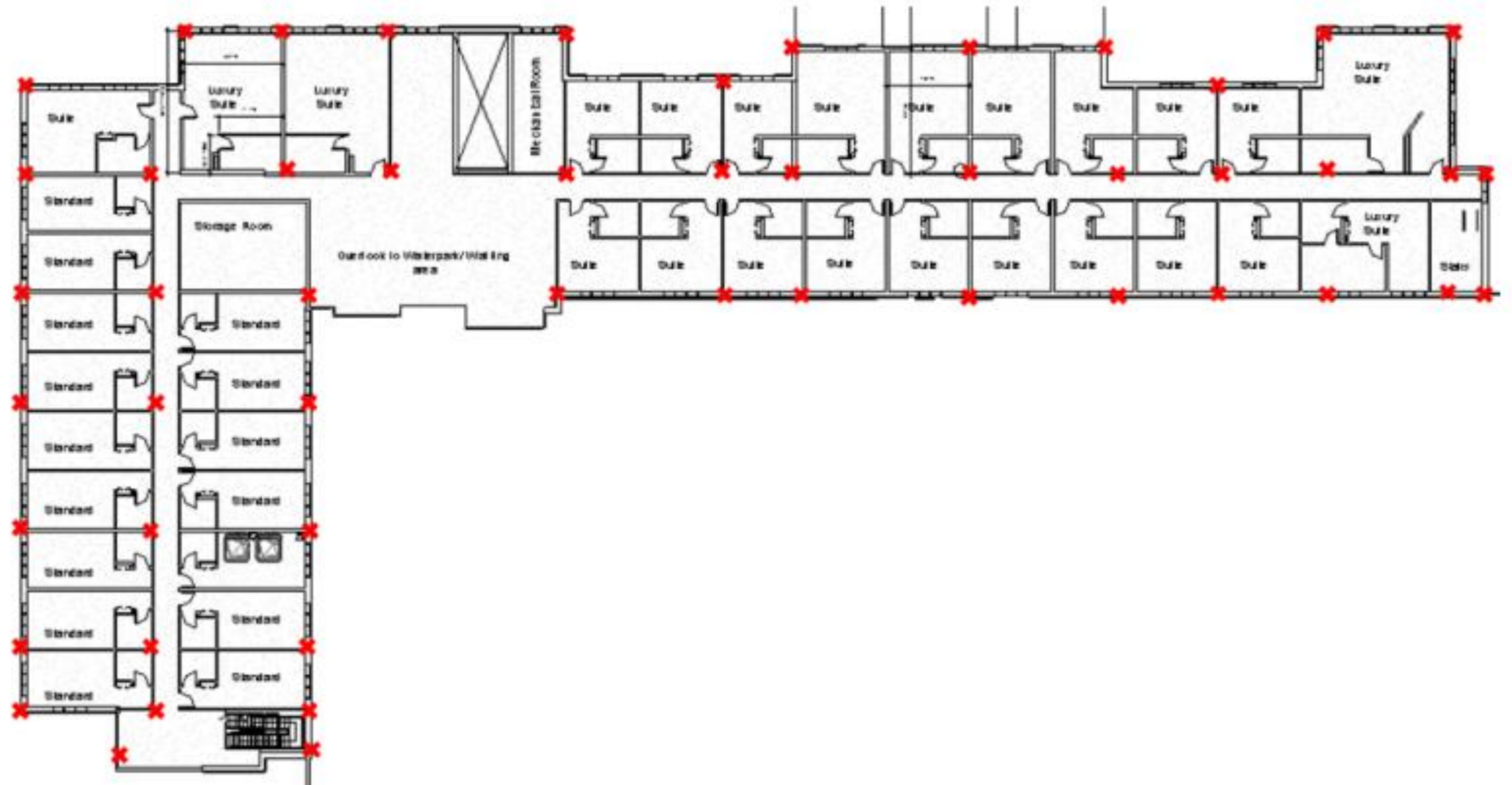
SCUB LEVEL COLUMN LOCATION:



FIRST FLOOR COLUMN LOCATION

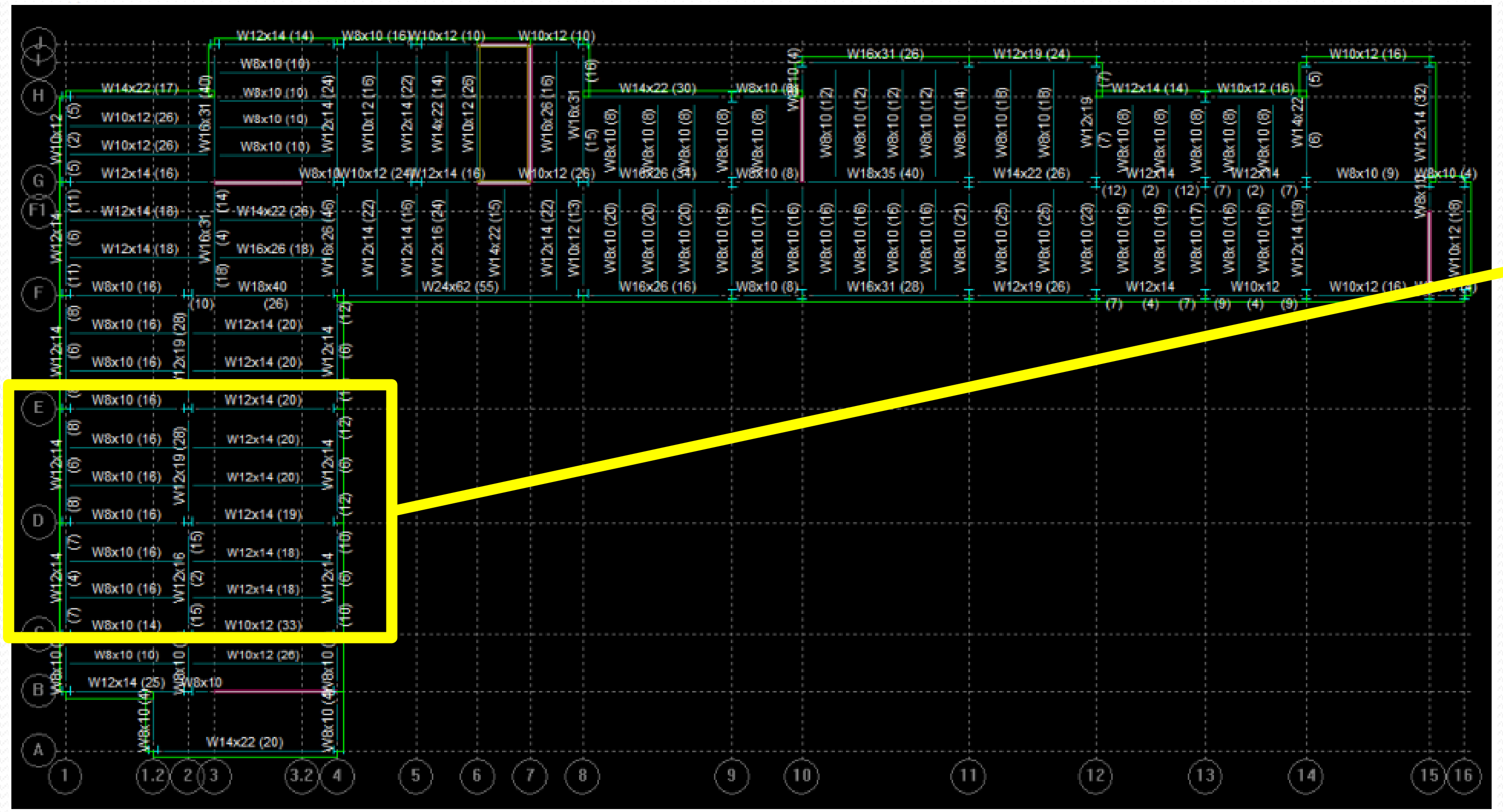


2-7TH FLOOR COLUMN LOCATION

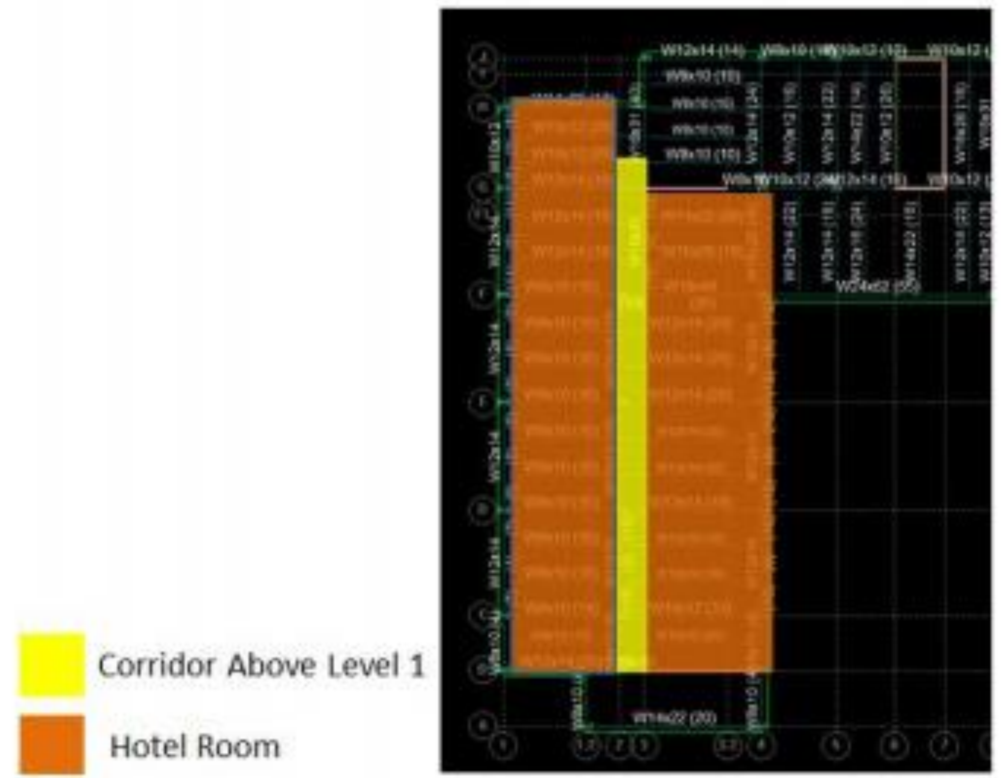


Structural Design: Hotel Gravity System

Typical Bay Design (Floor 2-7)

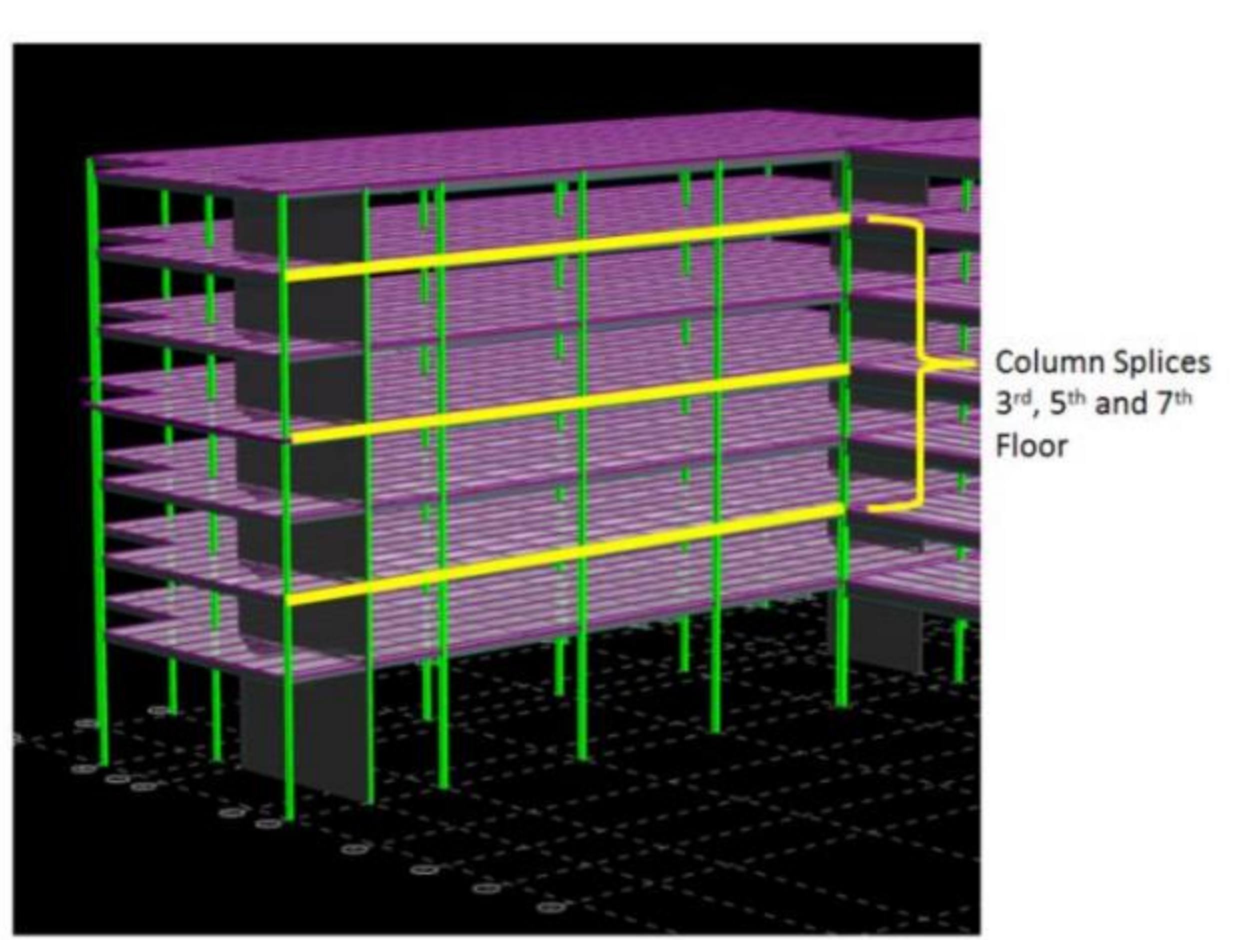


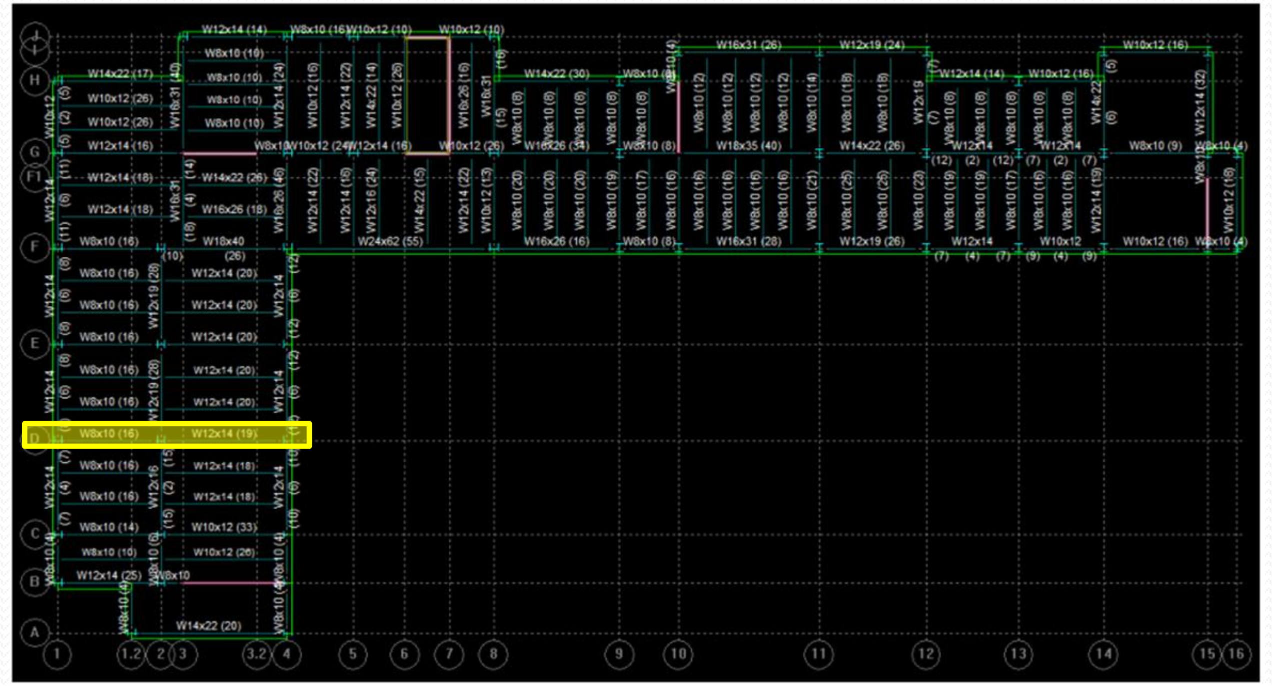
Typical Bay Loading

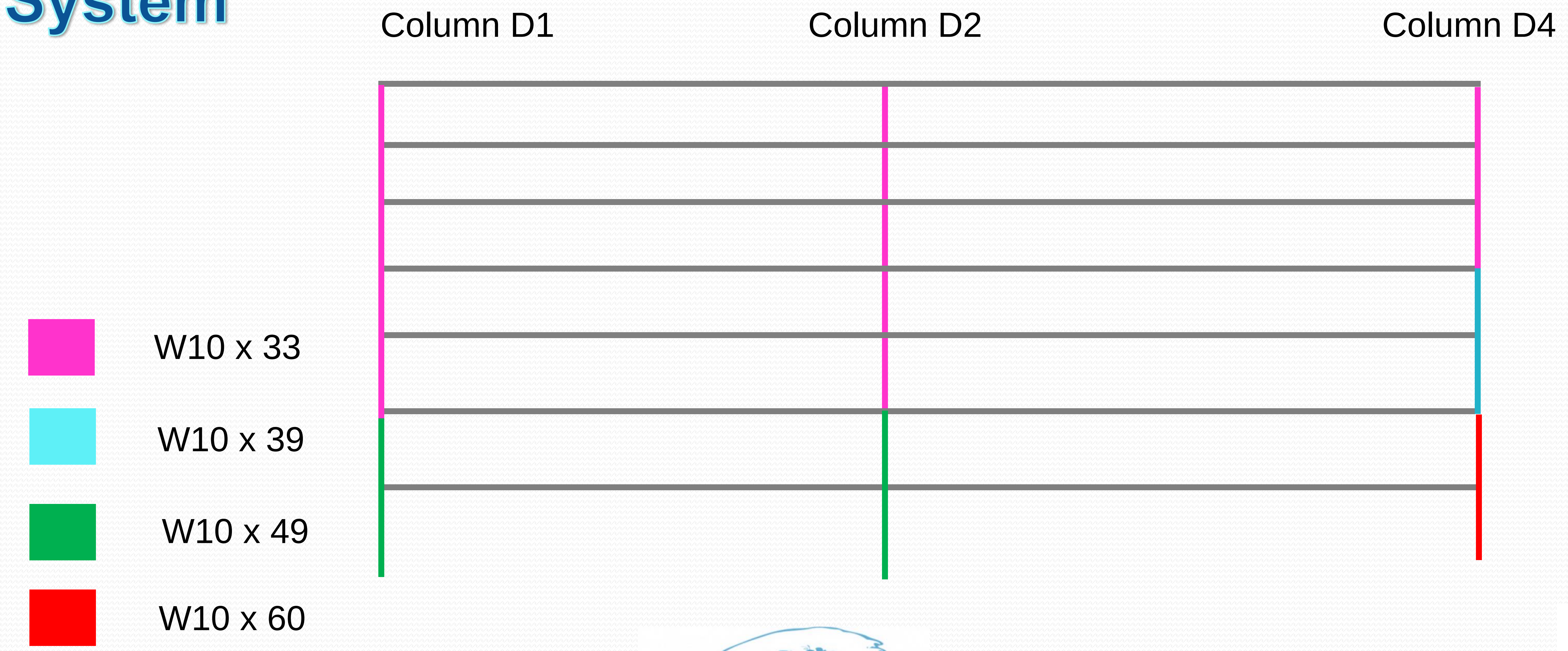


Structural Design: Hotel
Gravity System

Column Splice Locations







Lateral System:

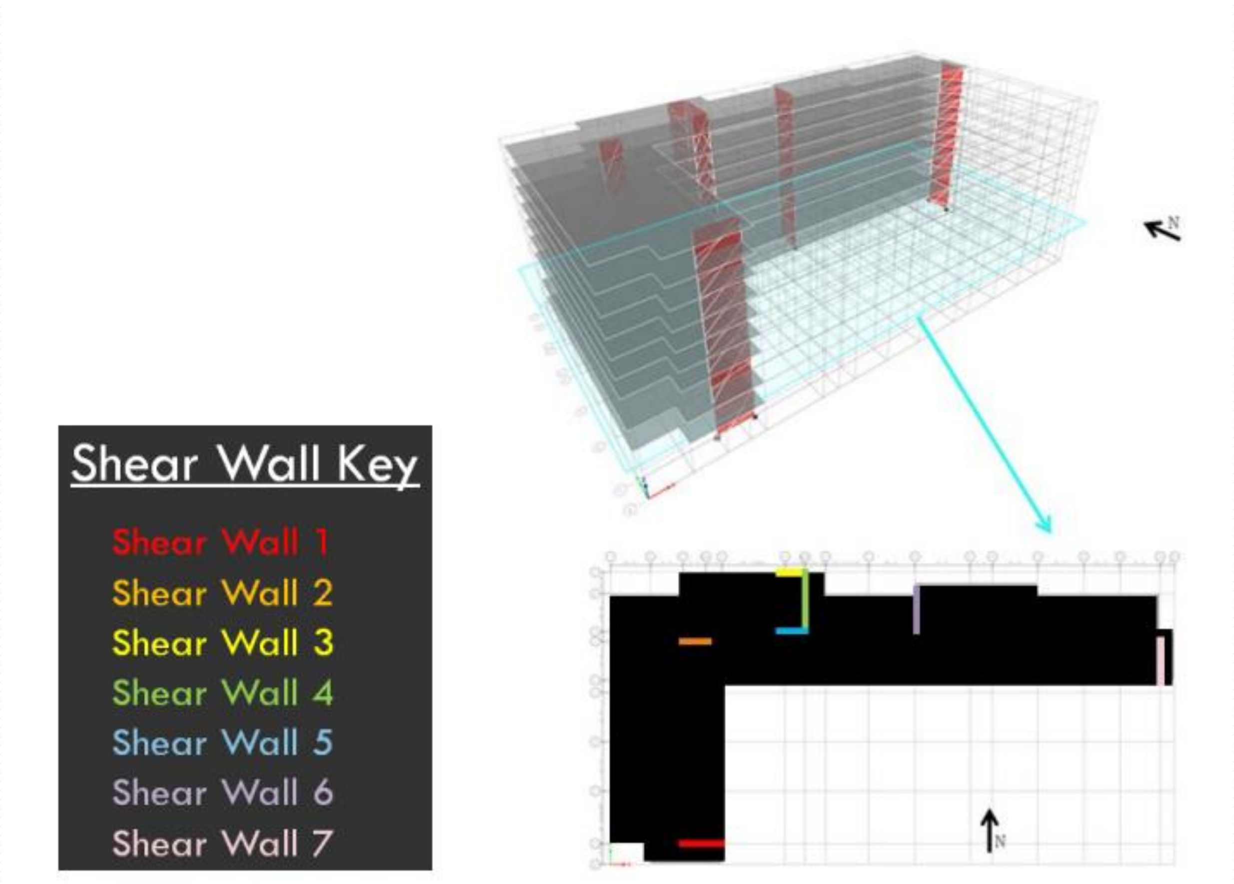
Structural Design: Hotel Lateral System

Shear Wall Information:

- 7 Ordinary Concrete Shear Walls
- 12” Thick
- Similar Design to Prince Frederick Hall

Change to Original Shear Walls:

- Shear Wall #2 was moved- Architectural Floor Plans
- Higher Loading Conditions: Updated Code



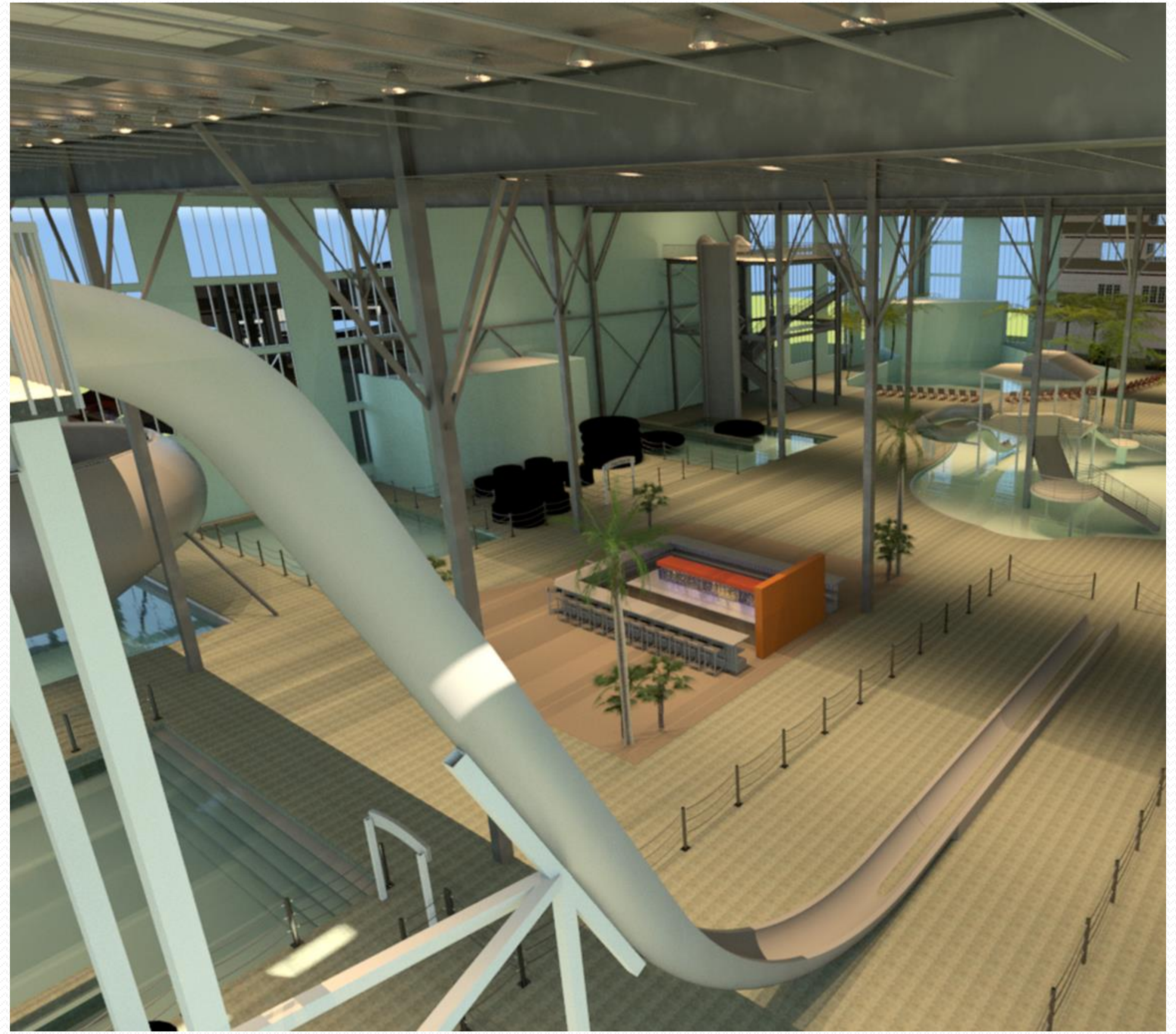
Structural Ram Model

Controlling Wind Load Deflections:

Case 3: Wind Loading 0.75 Y + Moment	
Level	Max Deflection (Inches)
Roof	1.728964
7th	1.483152
6th	1.27641
5th	1.071233
4th	0.869805
3rd	0.676528
2nd	0.496462
1st	0.224036

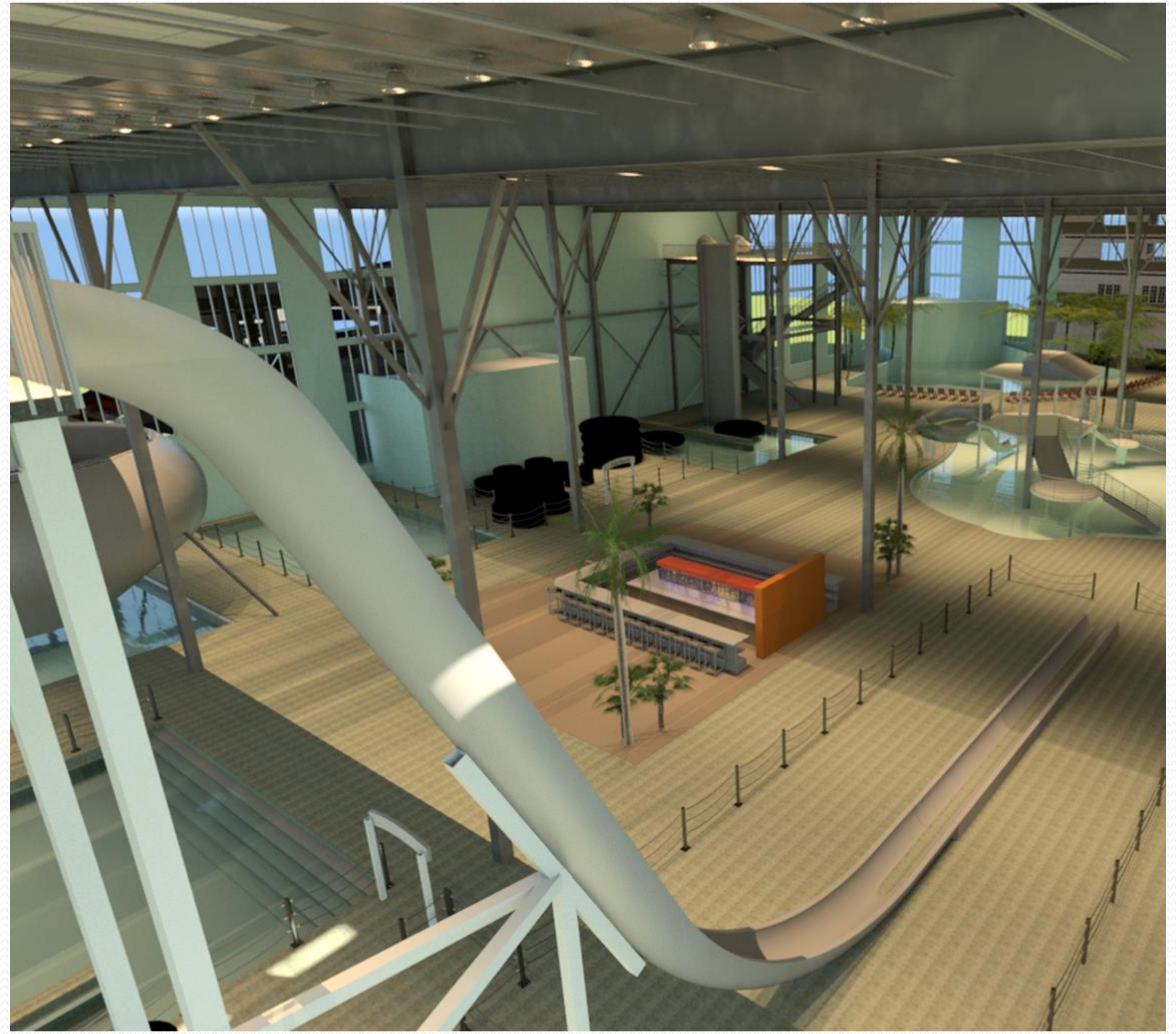
Seismic Loading Deflections:

Seismic Loading	
Level	Max Deflection (Inches)
Roof	1.031962
7th	0.891212
6th	0.773018
5th	0.655653
4th	0.540096
3rd	0.427802
2nd	0.320811
1st	0.152055



Conclusion

- A Exciting New Family Resort Was Created
- Architectural Design of Floor Plans Were Created
- Dynamic Loading Was Explored
- Water Slide Structure Was Designed
- Large Spanning Members were Designed For the Water Park
- Lateral Frames Were Designed
- Hotel Gravity and Lateral Were Explored



Acknowledgements

Entire AE Faculty

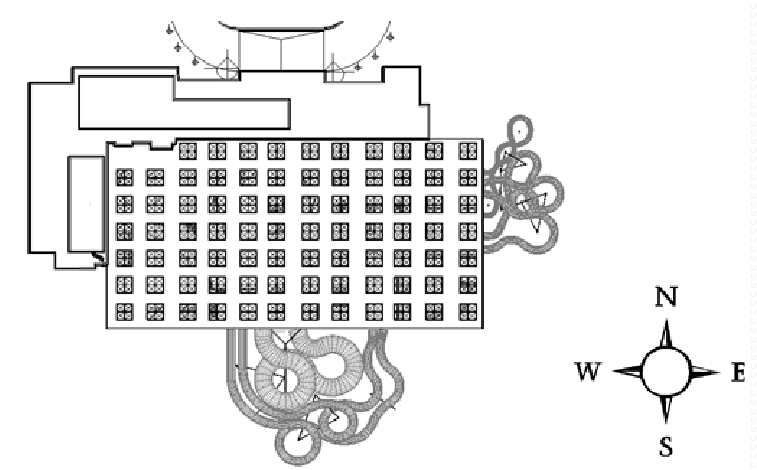
Professor Heather Sustersic
Dr. Thomas Boothby
Dr. Linda Hanagan
Professor Kevin Parfitt

Fellow AE Friends

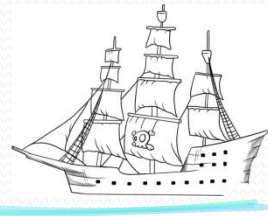
Friends and Family

QUESTIONS?

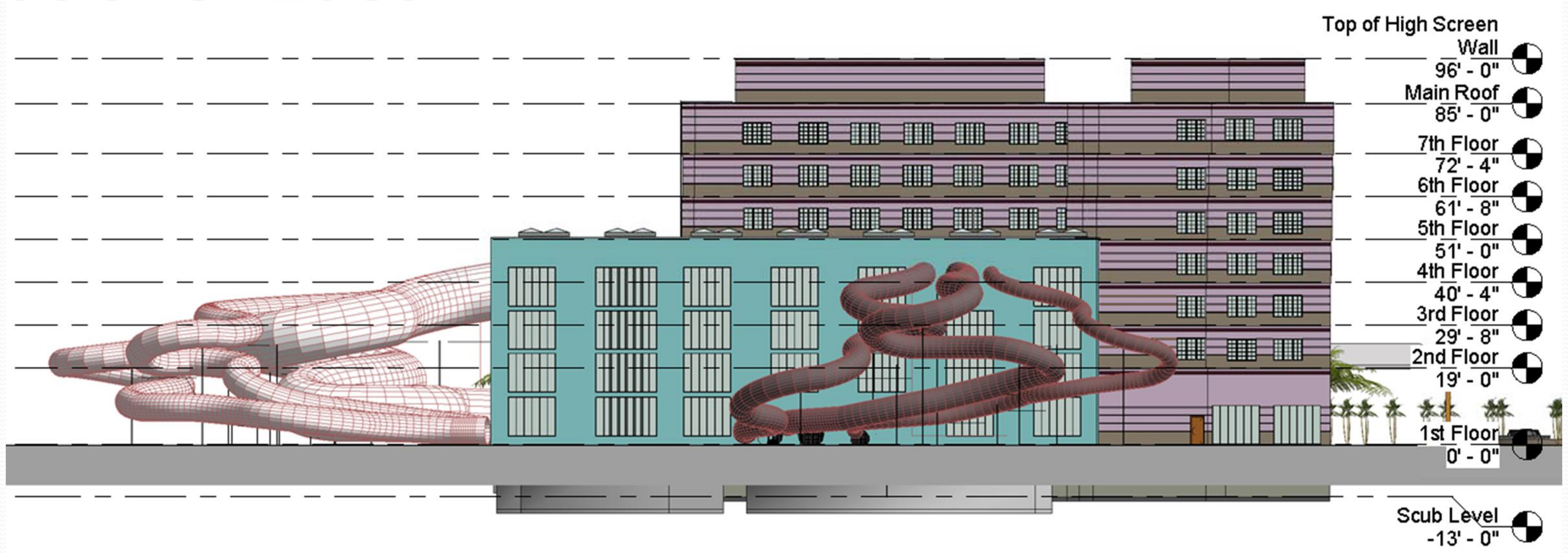
New Building Elevations: North

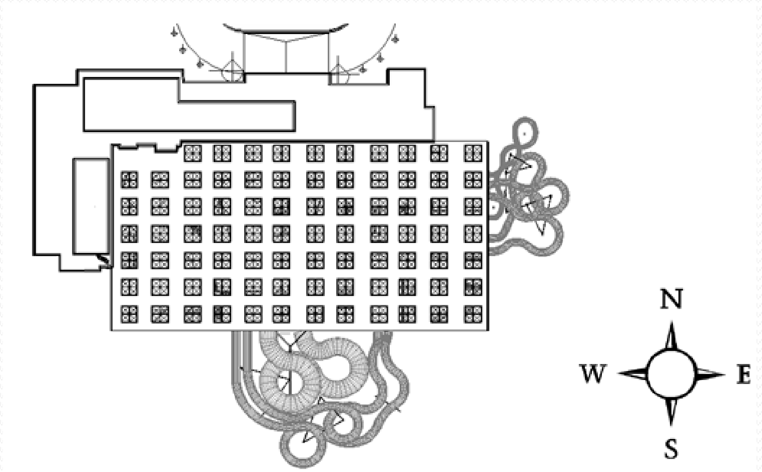


APPENDIX



New Building Elevations: East





APPENDIX

Economy Joist Table:

LRFD

ECONOMY TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown in Pounds per Linear Foot (plf)

Joist Designation	30K7	22K10	28K8	28K9	24K10	30K8	30K9	22K11	26K10	28K10	30K10	24K12	30K11	26K12	28K12	30K12
Depth (in.)	30	22	28	28	24	30	30	22	26	28	30	24	30	26	28	30
Approx. Wt. (lbs/ft.)	12.3	12.6	12.7	13	13.1	13.2	13.4	13.8	13.8	14.3	15	16	16.4	16.6	17.1	17.6
Span (ft.)																
22		825 / 548						825 / 548								
23		825 / 518						825 / 518								
24		825 / 495			825 / 544			825 / 495				825 / 544				
25		825 / 474			825 / 520			825 / 474				825 / 520				
26		825 / 454			825 / 499			825 / 454	825 / 541			825 / 499		825 / 541		
27		825 / 432			825 / 479			825 / 432	825 / 522			825 / 479		825 / 522		
28		825 / 413	825 / 543	825 / 543	825 / 456			825 / 413	825 / 501	825 / 543		825 / 456		825 / 501	825 / 543	
29		825 / 399	825 / 522	825 / 522	825 / 436			825 / 399	825 / 479	825 / 522		825 / 436		825 / 479	825 / 522	
30	825 / 543	825 / 385	825 / 500	825 / 500	825 / 422	825 / 543	825 / 543	825 / 385	825 / 459	825 / 500	825 / 543	825 / 422	825 / 543	825 / 459	825 / 500	825 / 543
31	801 / 508	825 / 369	825 / 480	825 / 480	825 / 410	825 / 520	825 / 520	825 / 369	825 / 444	825 / 480	825 / 520	825 / 410	825 / 520	825 / 444	825 / 480	825 / 520
32	751 / 461	775 / 337	772 / 438	823 / 463	823 / 393	823 / 500	823 / 500	823 / 355	823 / 431	823 / 463	823 / 500	823 / 393	823 / 500	823 / 431	823 / 463	823 / 500
33	706 / 420	729 / 307	726 / 399	790 / 432	798 / 368	780 / 460	798 / 468	798 / 334	798 / 404	798 / 435	798 / 468	798 / 368	798 / 468	798 / 404	798 / 435	798 / 468
34	664 / 384	687 / 280	684 / 364	744 / 395	753 / 337	735 / 420	774 / 441	774 / 314	774 / 378	774 / 410	774 / 441	774 / 344	774 / 441	774 / 378	774 / 410	774 / 441
35	627 / 351	648 / 257	645 / 333	702 / 361	709 / 308	693 / 384	751 / 415	741 / 292	751 / 356	751 / 389	751 / 415	751 / 324	751 / 415	751 / 356	751 / 389	751 / 415
36	592 / 323	612 / 236	609 / 306	663 / 332	670 / 283	654 / 353	712 / 383	700 / 269	729 / 334	730 / 366	730 / 392	730 / 306	730 / 392	730 / 334	730 / 366	730 / 392
37	559 / 297	579 / 217	576 / 282	627 / 305	634 / 260	619 / 325	673 / 352	663 / 247	690 / 308	711 / 344	711 / 374	711 / 290	711 / 374	711 / 315	711 / 344	711 / 374
38	531 / 274	549 / 200	546 / 260	594 / 282	601 / 240	586 / 300	639 / 325	628 / 228	654 / 284	691 / 325	691 / 353	691 / 275	691 / 353	691 / 299	691 / 325	691 / 353
39	504 / 253	520 / 185	519 / 240	564 / 260	570 / 222	556 / 277	606 / 300	595 / 211	619 / 262	670 / 306	673 / 333	673 / 261	673 / 333	673 / 283	673 / 306	673 / 333
40	478 / 234	495 / 171	492 / 222	535 / 241	541 / 206	529 / 256	576 / 278	565 / 195	589 / 243	636 / 284	657 / 315	657 / 247	657 / 315	657 / 269	657 / 291	657 / 315
41	454 / 217	471 / 159	468 / 206	510 / 224	516 / 191	502 / 238	547 / 258	538 / 181	561 / 226	606 / 263	640 / 300	640 / 233	640 / 300	640 / 256	640 / 277	640 / 300
42	433 / 202	448 / 148	445 / 192	486 / 208	490 / 177	480 / 221	522 / 240	513 / 168	534 / 210	578 / 245	619 / 282	625 / 224	625 / 284	625 / 244	625 / 264	625 / 284
43	414 / 188	427 / 138	426 / 179	463 / 194	468 / 165	457 / 206	498 / 223	489 / 157	508 / 195	550 / 228	591 / 263	609 / 213	610 / 270	610 / 232	610 / 252	610 / 270
44	394 / 176	408 / 128	406 / 167	442 / 181	447 / 154	436 / 192	475 / 208	466 / 146	486 / 182	525 / 212	564 / 245	580 / 199	597 / 258	597 / 222	597 / 240	597 / 258
45	376 / 164		388 / 156	423 / 169	427 / 144	417 / 179	454 / 195		465 / 170	501 / 198	538 / 229	555 / 185	583 / 246	583 / 212	583 / 229	583 / 246
46	361 / 153		372 / 146	405 / 158	408 / 135	399 / 168	435 / 182		444 / 159	480 / 186	516 / 214	531 / 174	570 / 236	570 / 203	570 / 219	570 / 236
47	345 / 144		355 / 138	387 / 148	391 / 126	382 / 157	415 / 171		426 / 149	459 / 174	493 / 201	508 / 163	558 / 226	553 / 192	558 / 210	558 / 226
48	331 / 135		340 / 128	370 / 138	375 / 118	366 / 148	399 / 160		408 / 140	441 / 163	472 / 188	487 / 153	543 / 215	529 / 180	547 / 201	547 / 215
49	318 / 127		327 / 120	355 / 130		351 / 139	382 / 150		391 / 131	423 / 153	454 / 177		520 / [illegible]	508 / 169	535 / 193	535 / 207
50	304 / 119		313 / 113	342 / 123		337 / 130	367 / 141		375 / 124	405 / 144	436 / 166		499 / 190	487 / 158	525 / 185	525 / 199
51	292 / 112		301 / 106	328 / 115		324 / 123	352 / 133		361 / 116	390 / 136	418 / 157		480 / 179	469 / 150	507 / 175	514 / 192

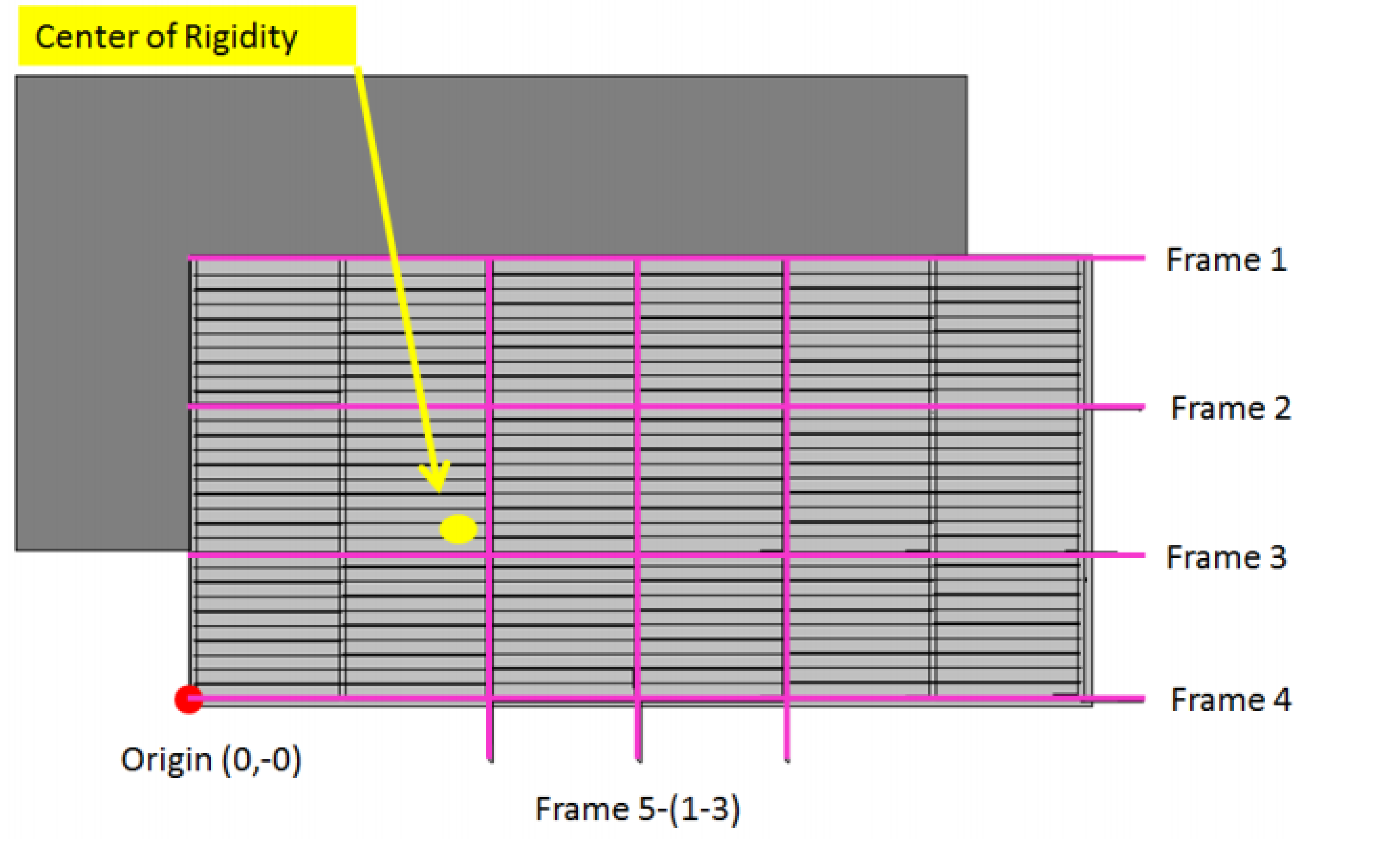
APPENDIX

Water Park Frame Stiffness:

Designation	Deflection (inch) {Dummy Load}	Stiffness K (K/in)
Frame 1	0.039	25.60
Frame 2	0.021	47.60
Frame 3	0.024	41.67
Frame 4	0.021	47.60
Frame 5	0.007	142.80

Water Park Center of Rigidity :

Indoor Water Park Center of Rigidity									
	Distance From Zero Reference		Relative Rigidity						
Element	X (Ft)	Y (Ft)	Rx	Ry	RxY	RyX			
Frame 1	150	150	25.6	0	3840	0			
Frame 2	150	100	47.6	0	4760	0			
Frame 3	150	50	41.67	0	2083.5	0			
Frame 4	150	0	47.6	0	0	0			
Frame 5-1	75	100	0	142.8	0	10710			
Frame 5-2	75	150	0	142.8	0	10710			
Frame 5-3	75	200	0	142.8	0	10710			
								X bar r	Y bar r
Totals			162.47	428.4	10683.5	32130		75	65.75676



Water Park Wind Loading:

Wind Loading North-South Water Park							
Height	Zg	α	Kz	Kzt	Kd	V	qz
5	1200	7	0.57472	1	0.85	115	16.5391
10	1200	7	0.57472	1	0.85	115	16.5391
15	1200	7	0.57472	1	0.85	115	16.5391
20	1200	7	0.623954	1	0.85	115	17.9559
25	1200	7	0.66503	1	0.85	115	19.138
30	1200	7	0.700591	1	0.85	115	20.1613
35	1200	7	0.732137	1	0.85	115	21.0691
40	1200	7	0.760609	1	0.85	115	21.8885
45	1200	7	0.786641	1	0.85	115	22.6376
50	1200	7	0.810681	1	0.85	115	23.3295
51	1200	7	0.815281	1	0.85	115	23.4618

Height	qz	G	h/L	Cp	Cpi	P
5	16.53905277	1.2	0.34	0.8	0.18	12.900461
10	16.53905277	1.2	0.34	0.8	0.18	12.900461
15	16.53905277	1.2	0.34	0.8	0.18	12.900461
20	17.95590979	1.2	0.34	0.8	0.18	14.00561
25	19.13797531	1.2	0.34	0.8	0.18	14.927621
30	20.16133115	1.2	0.34	0.8	0.18	15.725838
35	21.06914234	1.2	0.34	0.8	0.18	16.433931
40	21.8884992	1.2	0.34	0.8	0.18	17.073029
45	22.63763177	1.2	0.34	0.8	0.18	17.657353
50	23.32945321	1.2	0.34	0.8	0.18	18.196974
51	23.46182289	1.2	0.34	0.8	0.18	18.300222

Roof Pressure			
0-h/2	0-25.5	0.9	16.47
h/2-h	25.5-51	0.9	16.47
h-2h	51-102	0.5	9.15
>2h	102-150	0.3	5.49

Wind Loading East to West							
Height	Zg	α	Kz	Kzt	Kd	V	qz
5	1200	7	0.57472	1	0.85	115	16.5391
10	1200	7	0.57472	1	0.85	115	16.5391
15	1200	7	0.57472	1	0.85	115	16.5391
20	1200	7	0.623954	1	0.85	115	17.9559
25	1200	7	0.66503	1	0.85	115	19.138
30	1200	7	0.700591	1	0.85	115	20.1613
35	1200	7	0.732137	1	0.85	115	21.0691
40	1200	7	0.760609	1	0.85	115	21.8885
45	1200	7	0.786641	1	0.85	115	22.6376
50	1200	7	0.810681	1	0.85	115	23.3295
51	1200	7	0.815281	1	0.85	115	23.4618

Height	qz	G	h/L	Cp	Cpi	P
5	16.53905277	1	0.34	0.8	0.18	10.254213
10	16.53905277	1	0.34	0.8	0.18	10.254213
15	16.53905277	1	0.34	0.8	0.18	10.254213
20	17.95590979	1	0.34	0.8	0.18	11.132664
25	19.13797531	1	0.34	0.8	0.18	11.865545
30	20.16133115	1	0.34	0.8	0.18	12.500025
35	21.06914234	1	0.34	0.8	0.18	13.062868
40	21.8884992	1	0.34	0.8	0.18	13.57087
45	22.63763177	1	0.34	0.8	0.18	14.035332
50	23.32945321	1	0.34	0.8	0.18	14.464261
51	23.46182289	1	0.34	0.8	0.18	14.54633

Roof Pressure			
0-h/2	0-25.5	0.9	13.05
h/2-h	25.5-51	0.9	13.05
h-2h	51-102	0.5	7.25
>2h	102-300	0.3	4.35

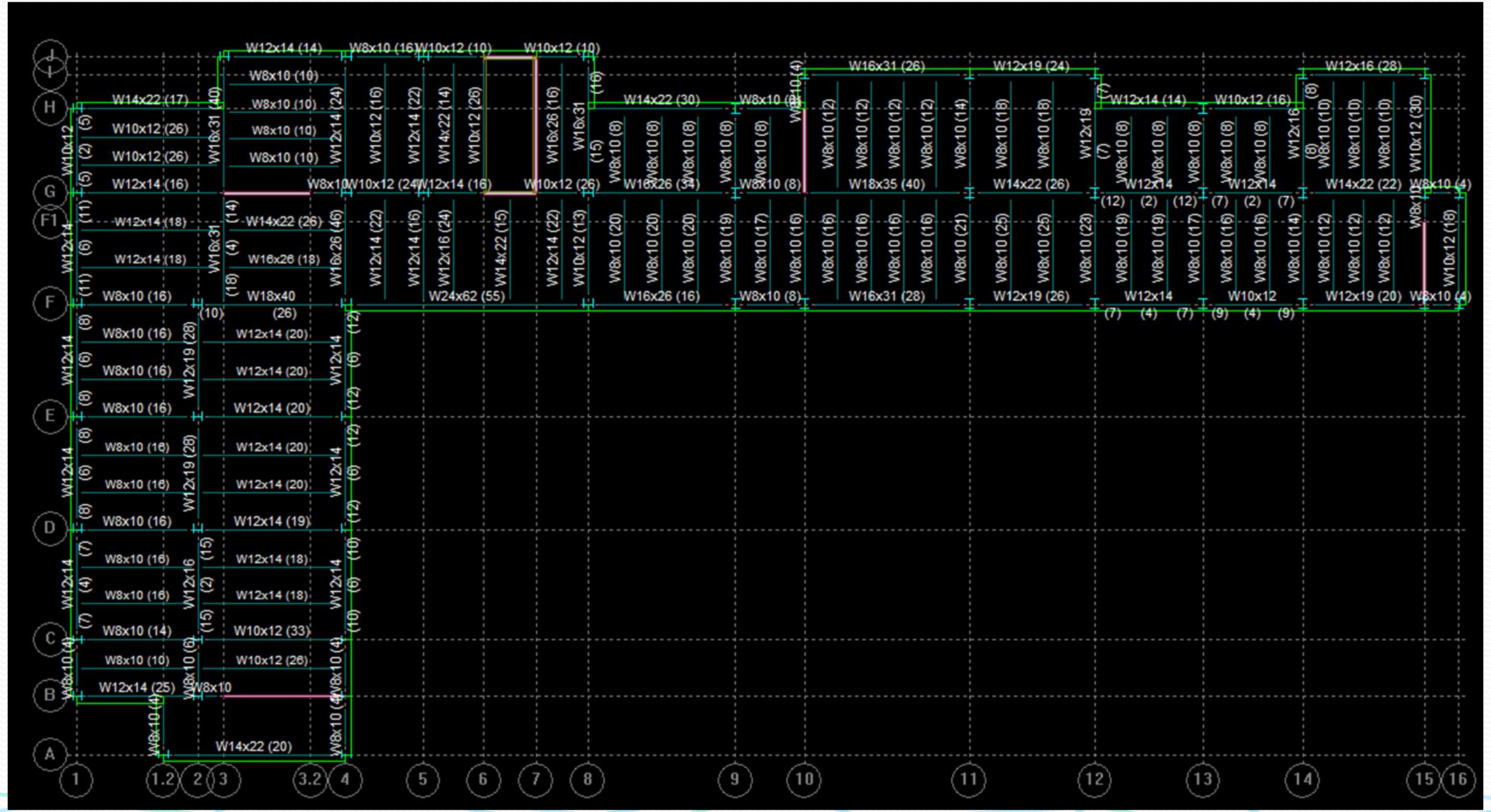
APPENDIX

Water Park Seismic Loading:

Indoor Water Park Weight							
Members	Quantity	Weight (lbs/ft)	Length (ft)	Total Weight (Kips)			
Joists	162	16.4	50	132.84			
Member	Quantity	Weight (lbs/cft)	Area(ft)	Length(ft)	Total Weight(Kips)		
Plate Girder 1	19	0.28	5.275	50	1.40315		
Plate Girder 2	1	0.28	43.8	100	1.2264		
Plate Girder 3	24	0.28	19.75	50	6.636		
Member	length(ft)	Width(ft)	Area	Weight (psf)	Total Weight		
Built-up Roof	300	150	45000	20	900		
Hvac	300	150	4500	12	54		
					Total Weight Roof (kips)		
					1096.10555		
Column Size	Quantity	Length(ft)	Weight(plf)	Total Weight (kips)			
HSS 14 x 14 x 5/8	23	51	110	129.03			
HSS 12 x 12 x 5/8	3	51	93.34	14.28102			
W 14 x 257	2	51	257	26.214			
HSS 3.5 x 3.5 x 5/8	94	20	14.72	27.6736			
					Total Weight (kips)		
					197.19862		
Seismic Loading Water Park							
		R	Ω	Cd			
Steel Eccentrically Braced Frames		8	3	5.5			
Seismic Base Shear							
Fa	Ss	Sms	Sds	Ic	Cs	W	V
1	0.75	0.75	0.5	1	0.0625	1293.304	80.83151

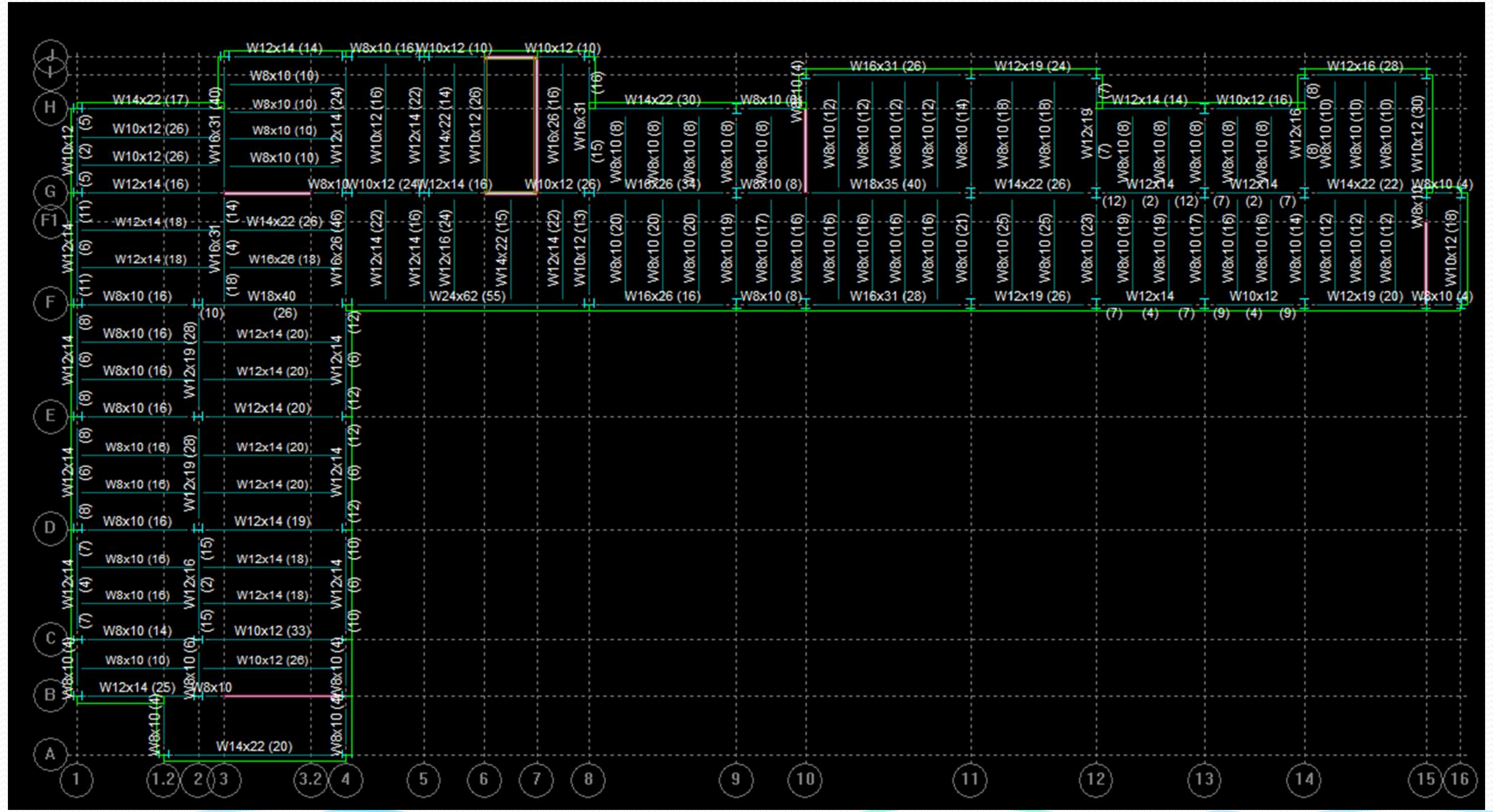
APPENDIX

Hotel Structure Floor Plans: First Floor



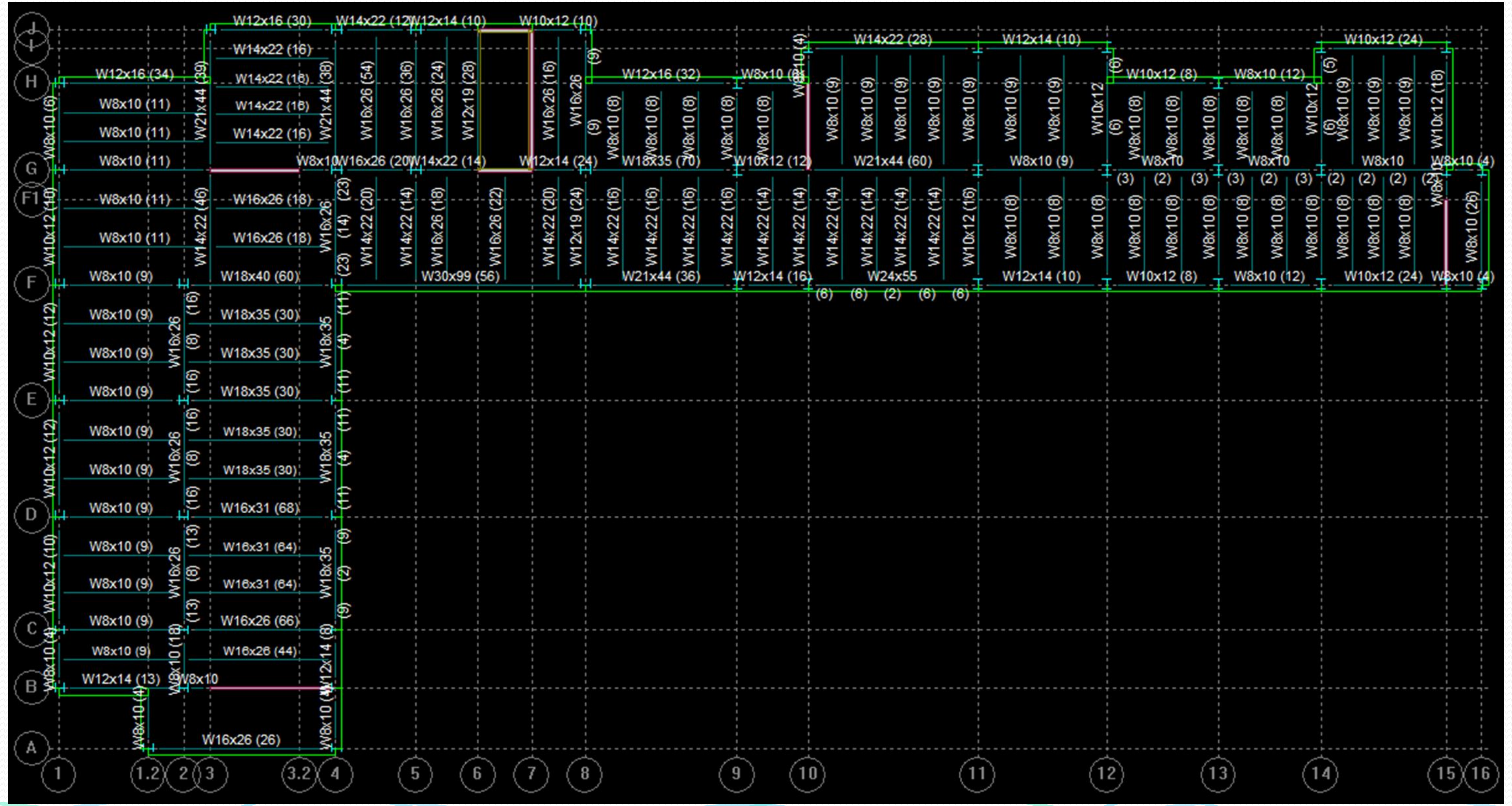
APPENDIX

Hotel Structure Floor Plans: 2nd -7th



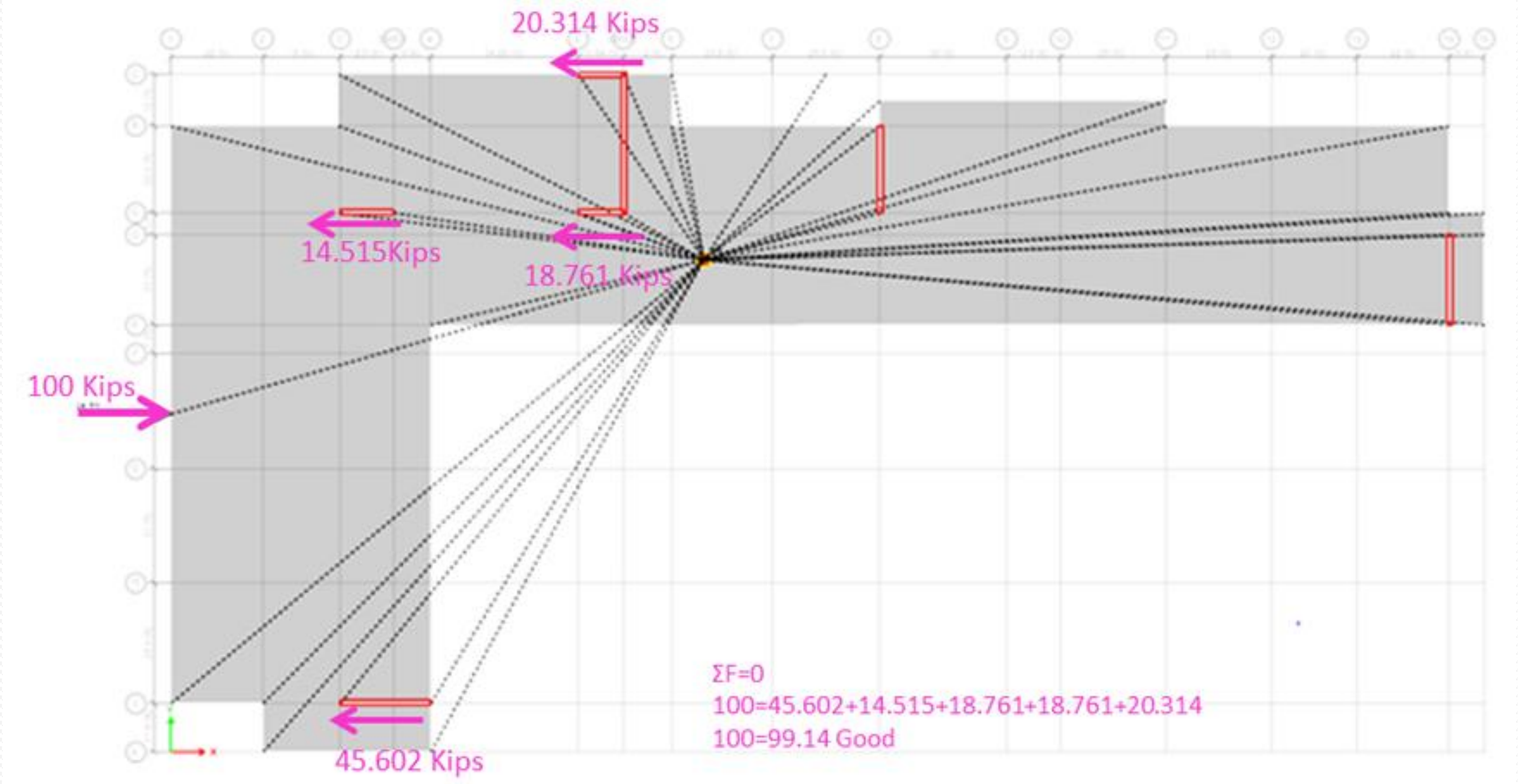
APPENDIX

Hotel Structure Floor Plans: Roof



APPENDIX

ETABS Model Check and COR:



Center of Rigidity: Hand Calculations vs. ETABS				
	Hand Calculations		ETABS Calculation	
	X	Y	X	Y
Ground Floor	168.4	81.0	164.8	73.2
First Floor	175.5	88.0	150.0	70.0
Second Floor	168.4	81.0	138.7	68.0
Third to Seventh Floor	177.5	112.2	120.0	70.0
Roof	175.8	88.4	130.0	70.0

APPENDIX

Hotel Wind Loading:

Wind Loading Hotel East-West																	
Height (ft)	B (ft)	L (ft)	V (mph)	Kd	Kzt	G	Gcpi	Zg	Kz	Q	Cp	Pww	Plw	Pt	Trib Width	Trib Height	F
15	160	320	115	0.85	1	0.85	0.18	0.85	0.623954	17.95591	0.8	8.977955	15.2586	24.23655	160	9.5	36.83956
19	160	320	115	0.85	1	0.85	0.18	0.9	0.667552	19.21054	0.8	9.605269	15.2586	24.86387	160	7.3	29.041
30	160	320	115	0.85	1	0.85	0.18	0.98	0.760609	21.8885	0.8	10.94425	15.2586	26.20285	160	10.6	44.44003
40	160	320	115	0.85	1	0.85	0.18	1.04	0.825768	23.76363	0.8	11.88181	15.2586	27.14041	160	10.6	46.03014
51	160	320	115	0.85	1	0.85	0.18	1.09	0.885124	25.47174	0.8	12.73587	15.2586	27.99447	160	10.6	47.47862
62	160	320	115	0.85	1	0.85	0.18	1.13	0.93592	26.93353	0.8	13.46676	15.2586	28.72536	160	10.6	48.71822
72	160	320	115	0.85	1	0.85	0.18	1.17	0.976772	28.10915	0.8	14.05458	15.2586	29.31318	160	10.6	49.71515
85	160	320	115	0.85	1	0.85	0.18	1.24	1.024211	29.47433	0.8	14.73716	15.2586	29.99576	160	10.8	51.83268
96	160	320	115	0.85	1	0.85	0.18	1.26	1.060449	30.51719	0.8	15.2586	15.2586	30.5172	160	5.5	26.85513

Wind Loading Hotel North-South																	
Height (ft)	B (ft)	L (ft)	V (mph)	Kd	Kzt	G	Gcpi	Zg	Kz	P	Q	Pww	Plw	Pt	Trib Width	Trib Height	F
15	320	160	115	0.85	1	0.85	0.18	0.85	0.57472	16.53905	0.8	8.269526	14.05458	22.32411	360	9.5	76.34844
19	320	160	115	0.85	1	0.85	0.18	0.9	0.614877	17.69468	0.8	8.84734	14.05458	22.90192	360	7.3	60.18625
30	320	160	115	0.85	1	0.85	0.18	0.98	0.700591	20.16133	0.8	10.08067	14.05458	24.13525	360	10.6	92.1001
40	320	160	115	0.85	1	0.85	0.18	1.04	0.760609	21.8885	0.8	10.94425	14.05458	24.99883	360	10.6	95.39553
51	320	160	115	0.85	1	0.85	0.18	1.09	0.815281	23.46182	0.8	11.73091	14.05458	25.78549	360	10.6	98.39744
62	320	160	115	0.85	1	0.85	0.18	1.13	0.862069	24.80827	0.8	12.40413	14.05458	26.45871	360	10.6	100.9665
72	320	160	115	0.85	1	0.85	0.18	1.17	0.899697	25.89113	0.8	12.94556	14.05458	27.00014	360	10.6	103.0326
85	320	160	115	0.85	1	0.85	0.18	1.24	0.943393	27.14858	0.8	13.57429	14.05458	27.62887	360	10.8	107.421
96	320	160	115	0.85	1	0.85	0.18	1.26	0.976772	28.10915	0.8	14.05458	14.05458	28.10916	360	5.5	55.65613

Epoxy Coating: (Sherwin Williams)

APPENDIX

Epoxy Coating Comparison Chart

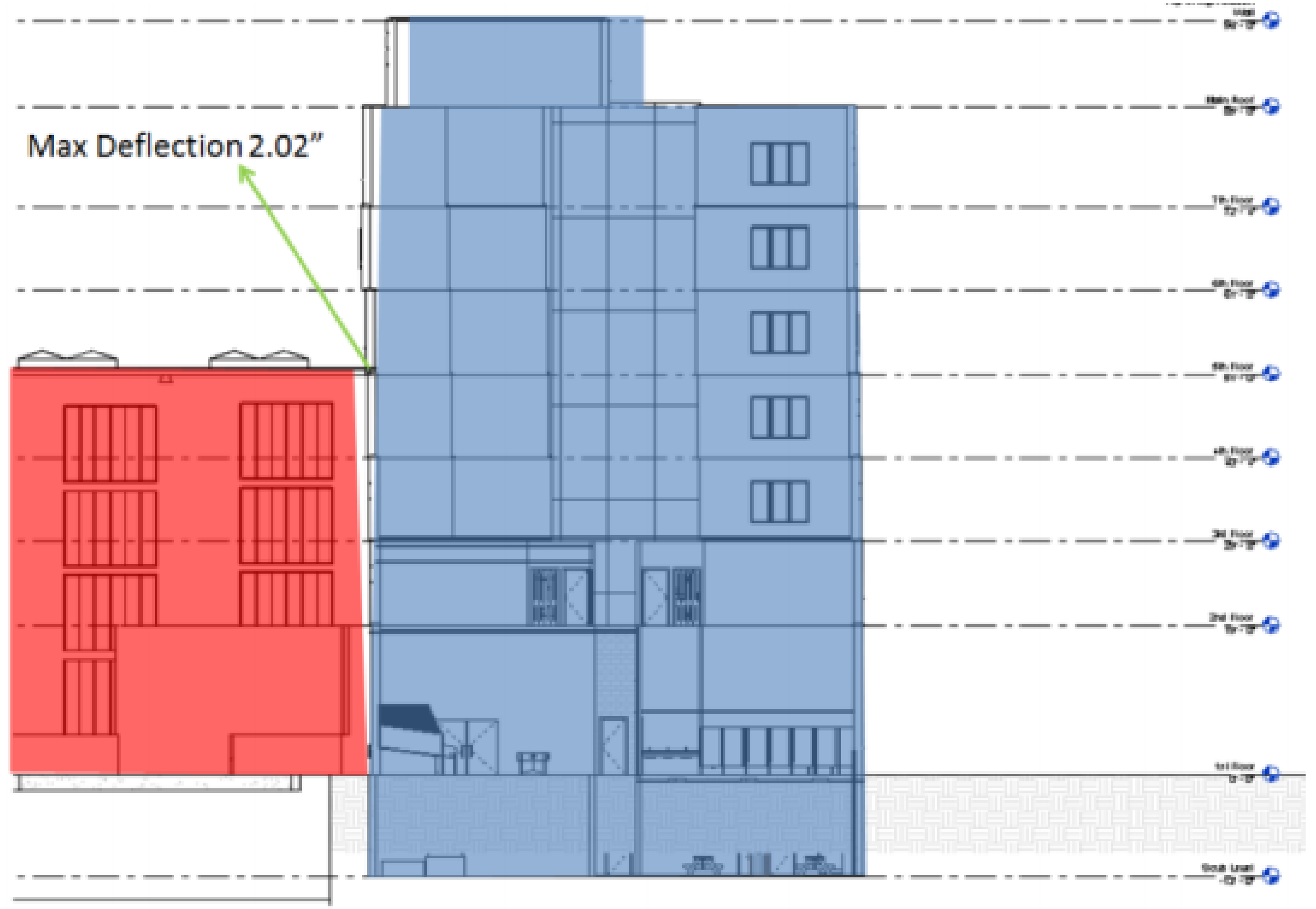
	Amine Epoxies	Polyamide Epoxies	Amidoamine Epoxies	Epoxy Phenolics/Novolacs
Description	Form very hard, adherent films with excellent chemical and corrosion resistance. Amine cured epoxies are often used as protective coatings and linings in highly corrosive environ-ments. Amine epoxies require care in handling since the amines can be moderately irritating to the skin, and may cause allergic reactions.	Polyamide epoxies generally offer the widest latitude in coating formulation. They are considered more resilient and flexible, and have better weathering resistance and a longer pot life than amine cured epoxies. Polyamide epoxies generally have less solvent and acid resistance than amine cured epoxies.	Amidoamines are reaction products of a polyamine and a fatty acid. Their properties generally fall between those of amines and polyamides. They have good water and corrosion resistance like amines, and good toughness like polyamides. They have relatively small molecular size giving them low visc-osities and making them very good surface wetters.	These coatings allow wide range formulating latitude. Novolac epoxy resin increases chemical resistance and solvent resistance. Increasing the level of phenolic increases the chemical and solvent resistance, but the coating loses flexibility. Some phenolics require heat curing.
Advantages	• Excellent alkali and water resistance • Very good acid resistance • Excellent solvent resistance • Hard, abrasion resistant film • Excellent corrosion resistance • Excellent wetting of substrate • Chemical/moisture barrier	• Very good alkali and water resistance • Good acid resistance • Longer pot life than amines • Easy to apply • Cures more quickly than amines • Good weathering characteristics • Good film flexibility • Excellent adhesion	• Excellent surface wetting • Excellent adhesion • Excellent water resistance • Low viscosity • Longer pot life than amines • Good gloss retention	• High heat resistance • Excellent chemical resistance • Excellent solvent resistance • Excellent corrosion resistance • Hard, abrasion resistant film
Disadvantages/ Limitations	• Amines can be irritating/toxic • Relatively short recoat time • Relatively short pot life • Slower dry than normal polyamides • Chalks/may discolor	• Faster dry than amines • Chalks • High viscosity • Temperature dependent • Slow cure	• Slow cure • Fair color retention • Temperature dependent	• Some may require heat cure • Relatively slow air cure • Chalks/may discolor • Relatively brittle
Primary Uses * Refer to product data sheets for specific use information	• Severe chemical resistant coating • Barrier coating • Offshore structures • Storage tanks, structural steel • Bridges, power plants • Tank linings • Secondary containment	• Water immersion • General industrial • Offshore structures • Storage tanks, structural steel • Water/wastewater plants • Tank linings • Bridges, power plants • Secondary containment	• Barrier coating • Surface tolerant coating • Where chemical and moisture resistance is required • General industrial • Refineries • Bridges, power plants	• Severe chemical resistance • Tank linings • Secondary containment • General industrial • Refineries • Bridges, power plants
S-W Products	Amines Shelcote II Epoxy Shelcote II Flake Filled Dura-Plate UHS Tank Clad HS Epoxy Sher-Glass FF Ketimines Dura-Plate MT Macropoxy 920 PrePrime Phenalkamines Dura-Plate 235 Water-Based Water-Based Tile-Clad Zinc Clad VI Fast Clad DTM Waterbased Epoxy	Kem Cati-Coat HS Filler/Sealer Tile-Clad High Solids Recoatable Epoxy Primer Copoxy Shop Primer Zinc Clad IV Zinc Clad III HS Hi-Solids Catalyzed Epoxy Macropoxy 646 Fast Cure Macropoxy 846 Winter Grade Epolon II Primer Epolon II Multi-Mil Macropoxy HS Epoxy Pro Industrial High Performance Epoxy	Epoxy Mastic Aluminum II	Phenicon HS Epoxy Phenicon Flake Filled Epo-Phen Nova-Plate UHS

Epoxies—Common Problems and Most Probable Causes

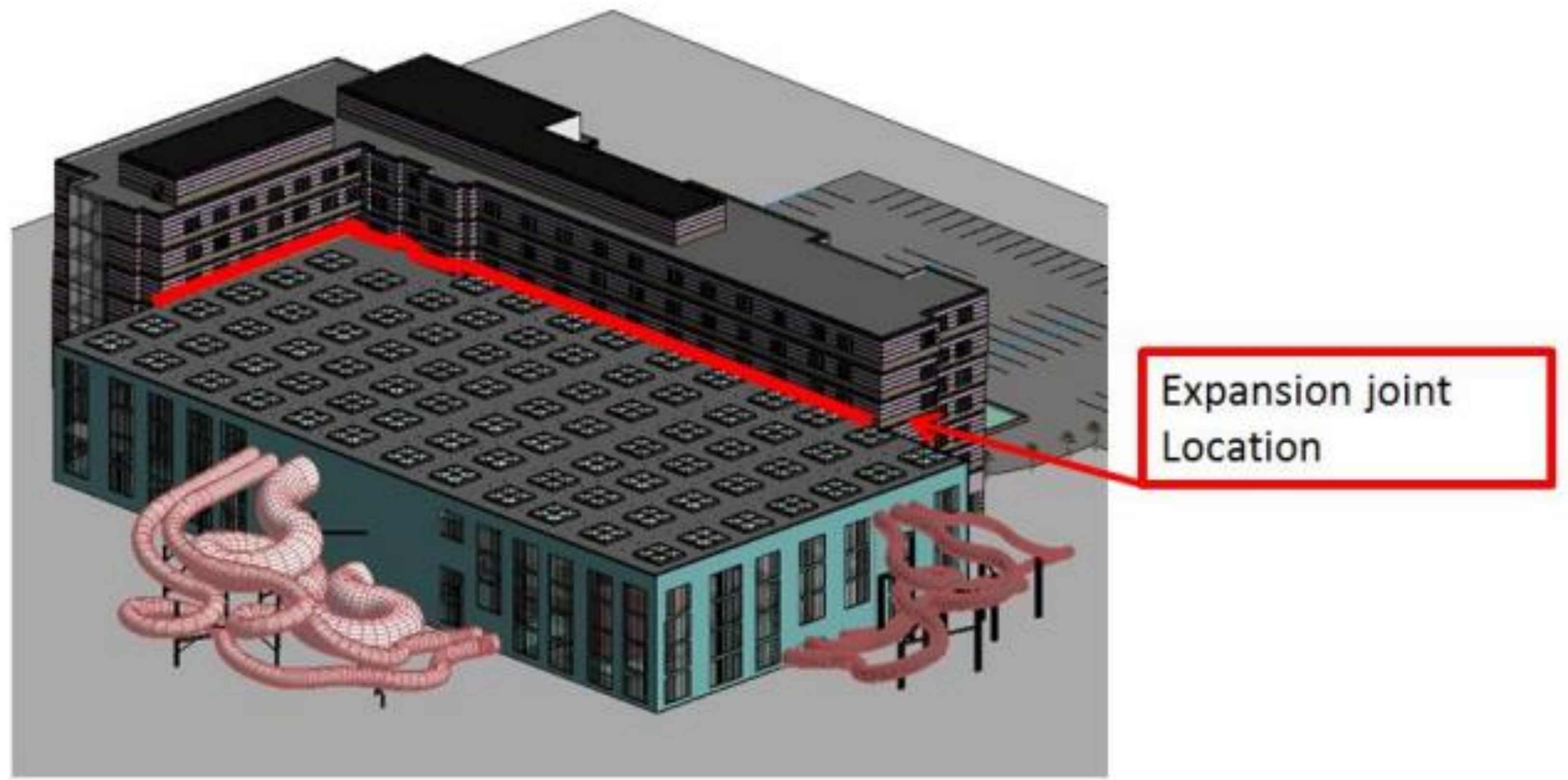
	Most Probable Causes																							
Common Problems	Surface Contamination	Application Method	Exceeded Pot Life	High Humidity	Improper Hardener	Sweat-In Time	Recoat Time	Tint Level	Improper Mix Ratio	UV Light Exposure	Absence of Light	Exposure to Chemicals	Wrong Reducer Solvent	Percent Reduction	Moisture/Condensation	Product Selection	Application Temperature	Surface Temperature	Initial Temperature 72 Hrs.	Film Thickness	Air Movement	Batch Variation	Primer	Surface Preparation
Discoloration/Yellowing			●	●	●	●			●	●	●	●			●	●	●	●	●		●			
Color Variation				●	●	●		●	●	●	●	●			●	●	●	●	●		●	●	●	
Blushing				●	●	●			●			●			●		●	●	●					
Uneven Gloss		●	●	●	●	●			●	●		●	●		●		●	●	●			●		●
Exotherm (Hot Paint)			●		●				●								●							
Poor Intercoat Adhesion	●		●	●	●	●	●		●			●				●	●	●	●	●			●	●
Soft Film				●	●	●		●	●			●	●		●		●	●	●	●	●			
Tacky Film/Slow Dry				●	●	●		●	●				●		●		●	●	●	●	●			
Lifting/Wrinkling	●				●		●						●	●	●					●	●		●	●
Bleeding	●						●	●								●							●	●
Pinholing	●	●			●		●						●		●									●
Cratering	●	●										●	●	●	●								●	●
Low Film Thickness		●							●					●										
Sagging		●	●	●			●		●				●	●		●	●		●		●			
Cracking/Crazing	●				●		●		●	●														
Alligatoring	●																			●			●	●

Image Courtesy of Sherwin Williams

Expansion Joint:



Expansion Joint Sizing			
Loading Case	Water Park Δ (inch)	Hotel 5th Floor Δ (inch)	Total deflection (inch)
Case 1	0.7	0.66	1.36
Case 2	1.51	0.51	2.02
Case 3	0.4	1.07	1.47
Case 4	1.01	0.8	1.81
Seismic	1.06	0.66	1.72



APPENDIX