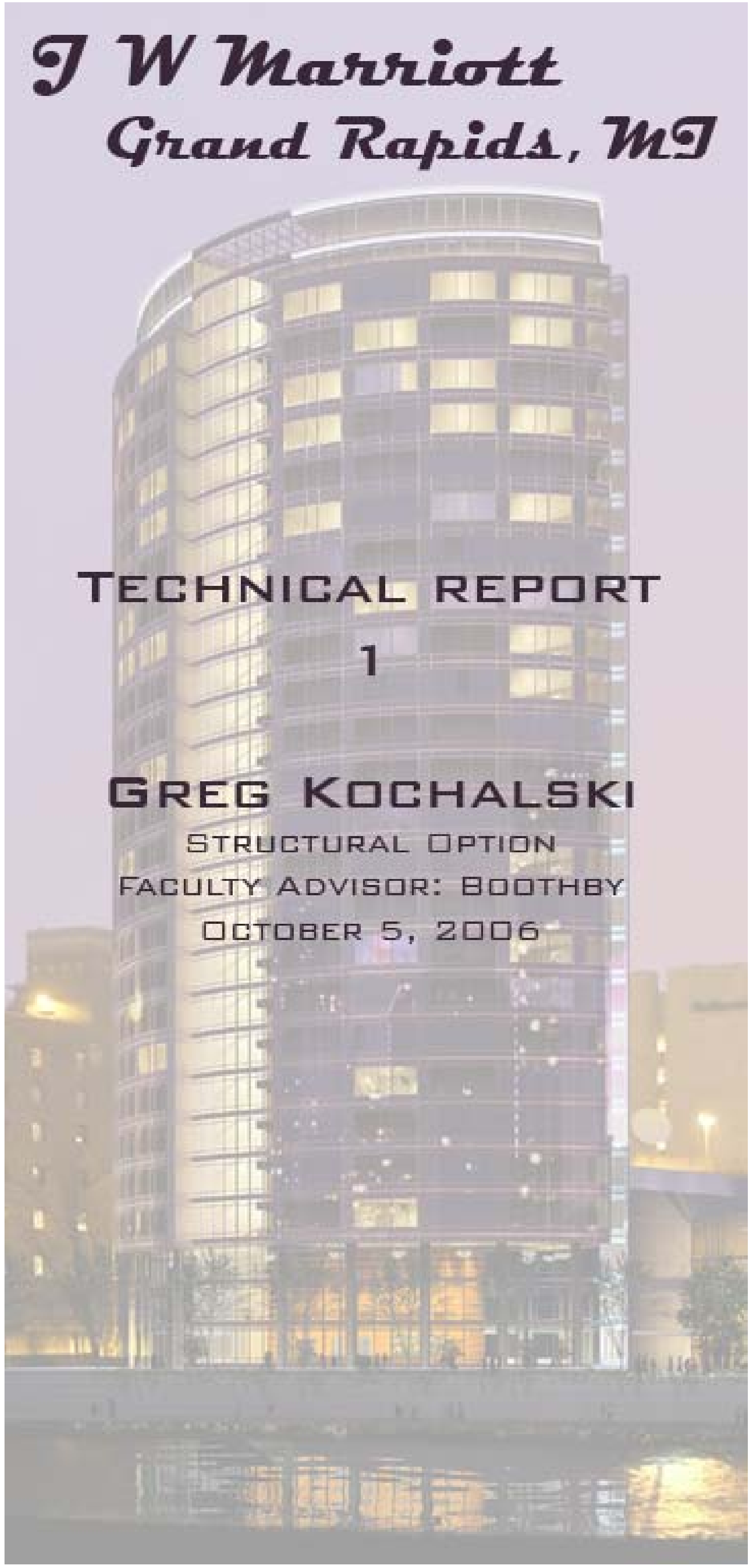
J W Marriott
Grand Rapids, MI



Technical report 1

Greg Kochalski
Structural Option
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October 5, 2006

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Executive Summary

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Building Profile:

The JW Marriott is a 24 story hotel under construction along the Grand River in the heart of downtown Grand Rapids, MI. The architect and structural engineer determined that the absence of perimeter columns would have large aesthetic benefits with minimal structural efficiency penalties. The unique elliptical shape of the JW Marriott offers a distinct identity in comparison to the otherwise conservative buildings in Grand Rapids.

The $95 million, 376,00 sf. complex will offer over 300 rooms and variety of uses to patrons. It includes a business center, restaurant, lounge, 24 hour room service and concierge, an adjacent parking structure offering over 550 spaces with a sky bridge, a fitness center, and a swimming pool. The JW Marriott will welcome its first guests in the fall of 2007.

Structural Codes:

Building Code:
Michigan Building Code 2003. The 2003 Michigan Building Code is an adoption of the IBC 2003 with state amendments.
Structural Concrete:
ACI 318-2002. Building Code Requirements for Structural Concrete.
Concrete Masonry:
ACI 530-1999. Building Code Requirements for Masonry Structures.
Structural Steel:
LRFD Specification for Structural Steel Buildings, 2nd Edition. AISC.

Calculations:

The aim of this report is to investigate and understand the JW Marriott's existing structural system. The report contains a detailed description of the foundation, framing, floor, lateral load resisting elements and systems. Calculations were prepared using industry standards and codes in a number of methods summarized herein. This investigation focuses on seismic forces, wind forces, and gravity load supporting elements. The report contains diagrams, descriptions, and tables which serve to clarify the methods used, assumptions made, and conclusions made regarding the JW Marriott.

2. Structural Description

2.1 Foundation:

The foundation of the JW Marriott consists of multiple parts. A slab on grade covers the entire basement with 6 inches of 4000 psi concrete reinforced with WWF and 10 inches of 4000 psi concrete reinforced with 4#12 bars each way in the loading dock area. Grade beams travel between the building elevator core pile caps, a few exterior pile caps, and the perimeter of the basement crawl spaces. The grade beams range in size from 16-28 inches wide by 42-48 inches in height. All grade beams are 6000 psi concrete reinforced top and bottom. Along the perimeter of the tower there are (21) piles that consist of (4-7) 200 ton micropiles. Each micropile drives 19’ into the ground. In the elevator core there is a cache of micropiles, (94) 200 ton. Just outside the elevator core there are two groups of 8 micropiles, one of each side of the core in the north-south direction. Throughout the interior of the basement the piles are on a 32’ bay spacing and consist of 4-6 micropile groups, with piles along the exterior and at changes in wall direction.

2.2 Framing:

The framing plan for the complex is separated into two distinct identities, the tower and the multi use facility. The tower is concrete and the multi use facility is steel.

2.2.1 Multi Use Facility:
The architect faced the challenge of incorporating spaces for the patrons such as business center, meeting rooms, and a second floor ballroom. The three floors of the facility are primarily 32’ bays. Columns are grade 50 W-shapes that range from W8x31 to W14x211.

2.2.2 Hotel Tower:
The repetitive tower framing plan offers a distinct advantage to the structural engineer and general contractor. The typical framing plans take affect from floor 5 through 23. On the first and second floor there are (21) reinforced concrete columns 24 inches in diameter. Fifteen of those columns are double heighted which creates a more impressive lobby entrance. The basement through sixth floor columns are made of 10,000 psi concrete, the seventh through thirteenth floor columns are 8000 psi, and the remaining floor columns are 4000 psi. After the fifth floor the number of round columns is reduced to four. The remaining columns are replaced by a series of 10 inch thick wall-columns to maximize guest views. The elevator core offers resistance throughout the entire height of the structure.

2.3 Floor System:

2.3.1 Multi Use Facility:
This section of the complex utilizes composite steel decking. The common slab includes 16-20 gauge metal decking with lightweight and normal weight concrete toppings, 4-6 inch toppings. The deck spans between grade 50 steel girders and beams on an average of 32'. The architect offers a focal point with the ballroom that spans an impressive 101' and employs a W12x45 bottom chord truss with double angle cross bracing LLBB. Interior movable partitions are capable of separating the ballroom into four separate event spaces.

2.3.2 Hotel Tower:
Similar to the framing system, the tower floor system becomes typical after the fifth floor. The first through third floors use a one way reinforced concrete slab system with concrete beams that span from the core to the exterior columns. The beams are 12–40 inches wide and 14-52 inches deep. A two way slab is found on the fourth and fifth floors. The rest of the tower uses a cast in place reinforced one way slab that spans the distance between wall columns.

2.4 Lateral Load Resisting System:

2.4.1 Multi Use Facility:
The lateral bracing for this portion of the complex is found on the perimeter of the building. The structural engineer decided on uniformity and only uses HSS shapes to provide lateral stability. There are a variety of bracing configurations that include diagonal bracing and chevron bracing; both can be found with and without eccentricities.

2.4.2 Hotel Tower:
The hotel tower uses a shear wall system to provide lateral load resistance. The four shear walls are found in the elevator core of the building. There are two 25' shear walls orientated East-West and a 35' and 11' shear wall in the North-South direction.

3. Loads

The loads for the JW Marriott are presented in an abridged form below. The Michigan Building Code 2003 adopts the live and dead loads from the IBC 2003. Design loads from the engineer of record and those according to the IBC 2003 are shown side by side.

Floor	Description	Design Dead Load (psf)	Design Live Load (psf)	IBC Dead Load (psf)	IBC Live Load (psf)
Ground	Main Lobby	10 MEP 40 Finishes	100	NA	100
-	Restaurant	10 MEP	100	-	100
-	Kitchen	10 MEP	100	-	NA
-	Public Rooms, Corridors, Stairs	10 MEP	100	-	100
-	Mechanical Room	10 MEP	150	-	NA
-	Office	20 Partition	50	-	50
Second	Typical	10 MEP	100	NA	100
-	Ballroom	10 MEP	100	-	100
-	Storage	10 MEP	125	-	125
-	Dishwash	10 MEP	125	-	NA
-	Mechanical Room	10 MEP	150	-	NA
-	Heavy Mech. Equipment	10 MEP	250	-	NA
Second Mezzanine	Mechanical, Storage Rooms	10 MEP	150	-	125 Storage
-	Heavy Mech. Equipment	10 MEP	250	-	NA
Third	Hotel Rooms, Hotel Corridors	20 Partition, MEP, etc.	40	-	40
-	Fitness	10 MEP	100	-	100
	Roof	20 Roofing, MEP 25 Paver	30	-	20 Roofing
-	Roof with High Snow Load	20 Roofing, MEP 25 Paver	100	-	20 Roofing 40 Snow
Fourth	Hotel Room, Hotel Corridors	20 Partition, MEP, etc.	40	-	40
-	Mechanical Room	10 MEP	150	-	NA
-	Roof	20 Roofing, MEP 25 Paver	35	-	20 Roofing

Fifth – Twenty Second	Hotel Rooms, Hotel Corridors	20 Partition, MEP, etc.	40	-	40
Mech. Penthouse	Mechanical Room	10 MEP	150	-	NA
-	Roof	45 Roofing, Sloped concrete 25 Pavers	100	-	20 Roofing 40 Snow
-	Roof with Mech. Equipment	15 MEP 20 Roofing, Concrete	150	-	NA MEP 20 Roofing
Roof	Roof, Helipad*	10 MEP 50 Topping Slab, Roofing	100 + 50 Snow or Helicopter	NA	20 Roofing 27 Snow

* Roofs used for other special purposes shall be designed for appropriate loads as approved by the authority having jurisdiction.

Table 3A

4. Calculations

4.1 Seismic Loads:

Seismic calculations were carried out in accordance with the equivalent lateral force procedure outlined in Section 9 of ASCE7-02. A summary of the calculations are presented herein. All relevant accelerations and factors have been determined in accordance with Section 9. The complete data, assumptions, and calculations may be found in Appendix A. The primary assumption was that the structure is Site Class D. The geotechnical report was not made available for this report.

GENERAL INFORMATION		
Occupancy Type	III	
Seismic Use Group	II	
Site Class	D	
Seismic Design Category	A	
Short period spectral response	S_s	0.10
Spectral response at 1 Sec	S_1	0.04
Maximum short period spectral response	S_{ms}	0.16
Maximum spectral response at 1 sec	S_{m1}	0.10
Design short period spectral response	S_{DS}	0.11
Design spectral response at 1 Sec	S_{D1}	0.06
Response Modification Coefficient	R	5.00
Seismic Response Coefficient	Cs	0.0208
Effective Period	T	1.28
Height Above Grade	h_{nTower}	$h_{nMulti\ Use}$
	256.13	48.16
Base Shear	V_{Tower}	$V_{Multi\ Use}$
	1602.58	221.86
Overturning Moment	M_{Tower}	$M_{Multi\ Use}$
	296396.7	7746.0

Table 4.1A

The information within this section is concerning the tower high-rise only. The multi use facility and high-rise portions of the complex were analyzed as two separate structures; both complete sets of calculations may be found in Appendix A.

The building weight is based on the column, slab, and dead loads of the building. The base shear was found to be approximately 1607 kips with an overturning moment of 296,400 ft-kips. Seismic loads were found to govern over those given by wind analysis.

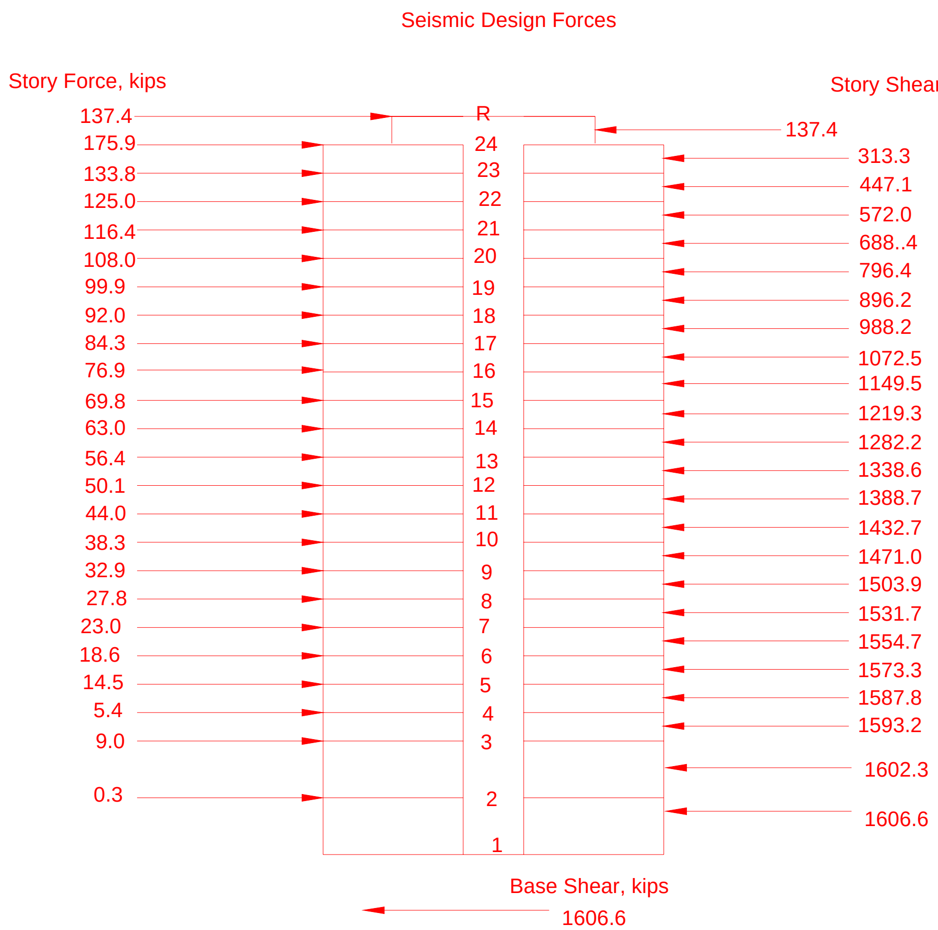


Figure 4.1A

TOWER LOADS					
Floor	$W_x h_x^k$	h	C_{vx}	F_x (kips)	Moment by floor (ft-kips)
1					
2	48849.3	19.66	0.0002	0.3	6.1
3	1427083.0	38.66	0.0056	9.0	349.7
4	851391.5	48.10	0.0034	5.4	259.6
5	2295102.2	57.60	0.0091	14.5	837.9

6	2934469.1	67.10	0.0116	18.6	1248.1
7	3631626.1	76.60	0.0144	23.0	1763.3
8	4383651.2	86.10	0.0173	27.8	2392.4
9	5188089.6	95.60	0.0205	32.9	3143.8
10	6042838.5	105.10	0.0239	38.3	4025.6
11	6946068.2	114.60	0.0275	44.0	5045.6
12	7896166.0	124.10	0.0312	50.1	6211.2
13	8891695.7	133.60	0.0352	56.4	7529.8
14	9931366.6	143.10	0.0393	63.0	9008.2
15	11014009.9	152.60	0.0436	69.8	10653.5
16	12138560.0	162.10	0.0480	76.9	12472.1
17	13304040.1	171.60	0.0526	84.3	14470.8
18	14509549.8	181.10	0.0574	92.0	16655.7
19	15754255.8	190.60	0.0623	99.9	19033.2
20	17037383.2	200.10	0.0674	108.0	21609.3
21	18358209.3	209.60	0.0726	116.4	24390.0
22	19716057.4	219.10	0.0780	125.0	27381.2
23	21110292.5	228.60	0.0835	133.8	30588.7
24	27747402.3	239.60	0.1097	175.9	42140.5
Roof	21672086.4	256.10	0.0857	137.4	35180.4
	Total			Total = V	Total = M
	252830243.7			1602.6	296396.7

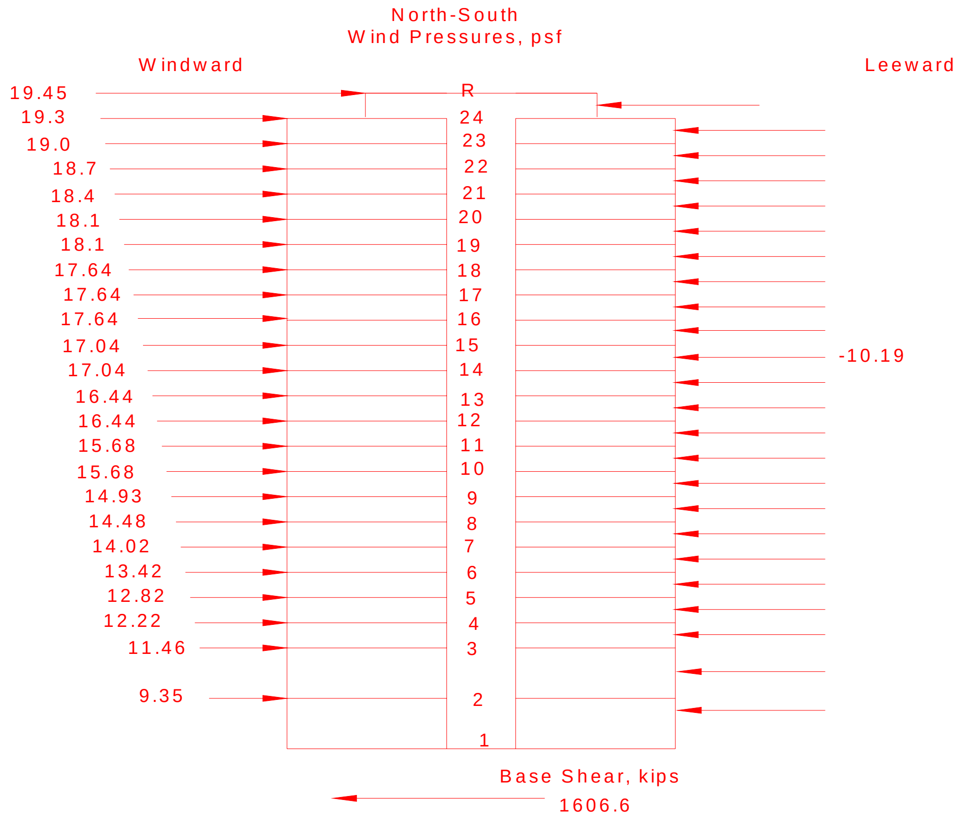
Table 4.1B

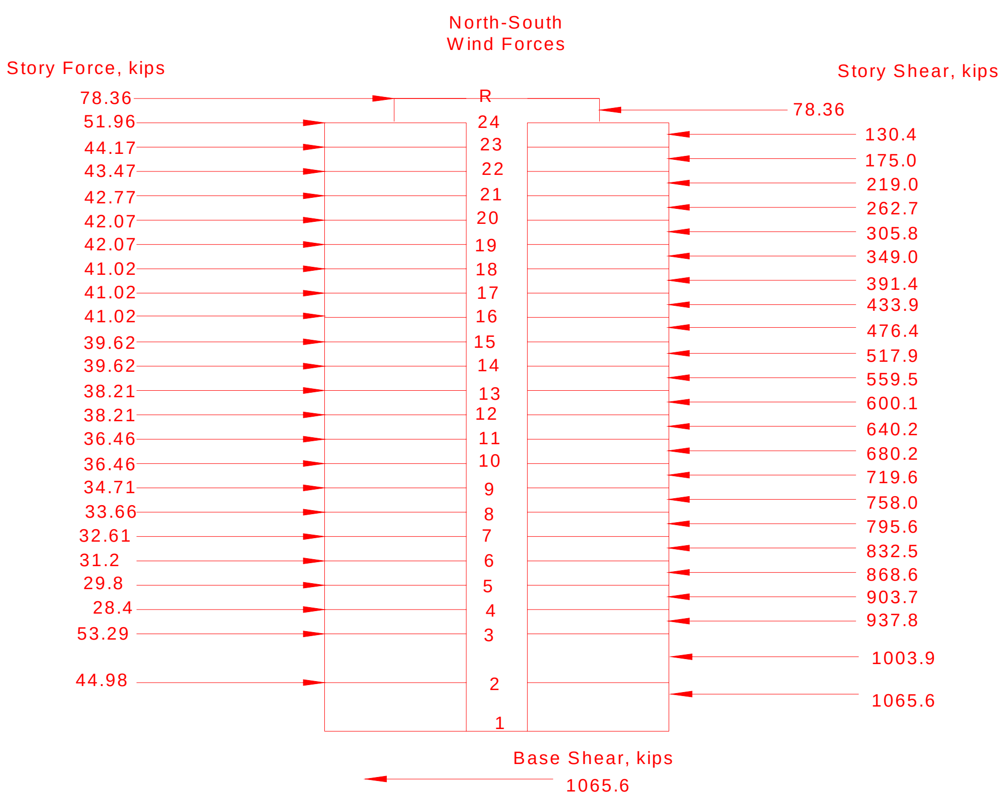
4.2 Wind Loads:

Wind loads determined for the JW Marriot were carried out under Section 6 of ASCE7-02. Factors were based on building characteristics, location, and height of the building. The high-rise and multi use portions of the building were analyzed as two separate structures. Assumptions include the normalization of the JW Marriott's elliptical shape into a rectangle of the same design width and length. The high-rise was found to be flexible and was analyzed as such. A summary of the complete analytical procedure is presented within this section. The complete analysis may be found in Appendix B.

GENERAL INFO		
Building Category	III	
Importance Factor, I	1.15	
Exposure Category	B	
k_d	0.85	
$k_{zt}=(1=k1k2k3)^2$	1.00	
V (mph)	90.00	
Period, T		
Tower	T_a	2.94
Multi use	T	0.40
C_T	0.02	
h_n	256.13	
x	0.90	
Frequency, n_1	0.34	
North South Length	160.61	
East West Length	95.34	
Building Height, h_n		
Tower	256.13	
Multi use	48.16	

Table 4.2A


North-South
Wind Pressures, psf
Windward
Leeward
19.45
19.3
19.0
18.7
18.4
18.1
18.1
17.64
17.64
17.64
17.04
17.04
16.44
16.44
15.68
15.68
14.93
14.48
14.02
13.42
12.82
12.22
11.46
9.35
R
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
-10.19
Base Shear, kips
1606.6


North-South
Wind Forces
Story Force, kips
Story Shear, kips
78.36
51.96
44.17
43.47
42.77
42.07
42.07
41.02
41.02
41.02
39.62
39.62
38.21
38.21
36.46
36.46
34.71
33.66
32.61
31.2
29.8
28.4
53.29
44.98
R
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
78.36
130.4
175.0
219.0
262.7
305.8
349.0
391.4
433.9
476.4
517.9
559.5
600.1
640.2
680.2
719.6
758.0
795.6
832.5
868.6
903.7
937.8
1003.9
1065.6
Base Shear, kips
1065.6

TOWER			Pressures (psf)			
Floor	h(above gr	Floor height	NS windward	NS leeward	EW windward	EW leeward
1	0.00					
2	19.66	19.66	9.35	-10.19	9.25	-5.57
3	38.66	19.00	11.46	-10.19	11.34	-5.57
4	48.10	9.50	12.22	-10.19	12.08	-5.57
5	57.60	9.50	12.82	-10.19	12.68	-5.57
6	67.10	9.50	13.42	-10.19	13.28	-5.57
7	76.60	9.50	14.02	-10.19	13.87	-5.57
8	86.10	9.50	14.48	-10.19	14.32	-5.57
9	95.60	9.50	14.93	-10.19	14.77	-5.57
10	105.10	9.50	15.68	-10.19	15.52	-5.57
11	114.60	9.50	15.68	-10.19	15.52	-5.57
12	124.10	9.50	16.44	-10.19	16.26	-5.57
13	133.60	9.50	16.44	-10.19	16.26	-5.57
14	143.10	9.50	17.04	-10.19	16.86	-5.57
15	152.60	9.50	17.04	-10.19	16.86	-5.57
16	162.10	9.50	17.64	-10.19	17.45	-5.57
17	171.60	9.50	17.64	-10.19	17.45	-5.57
18	181.10	9.50	17.64	-10.19	17.45	-5.57
19	190.60	9.50	18.10	-10.19	17.90	-5.57
20	200.10	9.50	18.10	-10.19	17.90	-5.57
21	209.60	9.50	18.40	-10.19	18.20	-5.57
22	219.10	9.50	18.70	-10.19	18.50	-5.57
23	228.60	9.50	19.00	-10.19	18.80	-5.57
24	239.60	11.00	19.30	-10.19	19.10	-5.57
Roof	256.10	16.46	19.45	-10.19	19.24	-5.57

Table 4.2B

TOWER	Forces (k)		Shears (k)	
Floor	N/S	E/W	N/S	E/W
1				
2	61.69	27.77	1065.64	515.59
3	66.06	30.62	1003.95	487.82
4	34.18	15.99	937.89	457.20
5	35.10	16.53	903.71	441.22
6	36.02	17.07	868.61	424.69
7	36.94	17.61	832.58	407.62
8	37.63	18.01	795.64	390.02
9	38.32	18.42	758.01	372.00
10	39.47	19.09	719.68	353.59
11	39.47	19.09	680.21	334.49
12	40.62	19.77	640.74	315.40
13	40.62	19.77	600.11	295.63
14	41.54	20.31	559.49	275.86
15	41.54	20.31	517.94	255.55
16	42.47	20.85	476.40	235.24
17	42.47	20.85	433.93	214.39
18	42.47	20.85	391.47	193.54
19	43.16	21.26	349.00	172.69
20	43.16	21.26	305.85	151.44
21	43.62	21.53	262.69	130.18
22	44.08	21.80	219.07	108.66
23	44.54	22.07	175.00	86.86
24	52.10	25.86	130.46	64.80
Roof	78.36	38.93	78.36	38.93

Table 4.2C

4.3 Preliminary Analysis:

The following analyses were done in accordance with current codes and standard practices. A brief description is given of each spot check. The complete assumptions and calculations may be found within each calculation located in Appendix C.

4.3.1 Column Spot Check:
The column spot check was carried out on a typical first floor column located in the lobby of the JW. The columns are 30 inches in diameter typically throughout the design. The column was reinforced with 16#11 bars and uses 10ksi concrete on the lower levels analyzed. The capacity was found to be more than sufficient. It is important to note that the large discrepancy between capacity and design load is most likely due to the long unbraced length of 38 ft. The first floor columns span from the lobby floor to the ceiling of the third floor in parts of the lobby to create an awe inspiring space at the entrance.

4.3.2 Punching Shear Spot Check:
A two-way floor system was analyzed on the 6^{th} floor around a perimeter wall-column that becomes typical after the 5^{th} floor. These calculations were done by the requirements of ACI chapter 13. The two-way action was found to be sufficient after calculating the shear force using ACI equations 11-35, 11-33, and 11-34.

4.3.3 Shear Wall Spot Check:
The shear walls for the JW Marriott are located at the elevator core with two in each direction (figure 4.3.3A). Each wall is heavily reinforced, shear wall one and two that span East-West (solid red) have the most reinforcing. The analysis of the shear walls was carried out using the method of The Seismic Design Handbook, Naeim 2001. Torsion was not considered in this report and may be the cause of a seemingly over-design.

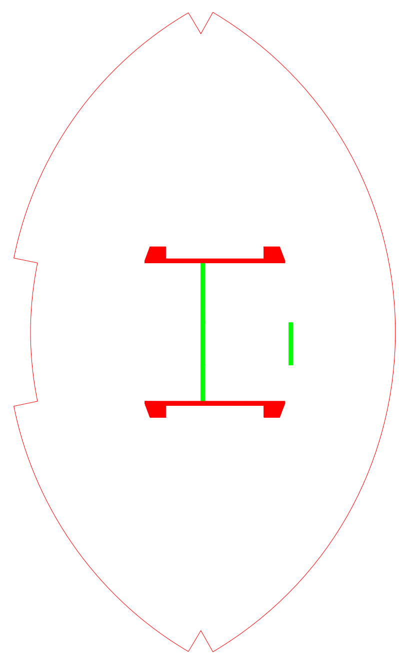


Figure 4.3.3A

4.3.4 Snow Load Spot Check:
This calculation was done using ASCE7-02 section 7.
The ground load was found using the provisions set forth in section 7.3 and the drift snow load was found per section 7.7. The ground snow load and drift snow loads were calculated to be 27 psf and 68 psf, respectively.

4.3.5 Beam Spot Check:
A preliminary analysis was done of a doubly reinforced concrete beam 2B3 along work line R6. The beam is 36 inches wide and 24 inches tall. The reinforcing includes 13 #9 bars distributed throughout the top and bottom of the beam. The span of the beam is 32 ft and is a single span only. No moment distribution analysis was needed in this spot check because there are no beams of continuous spans in the tower. The beam was found to be adequate in both shear and moment capacity. This may be due to the uniformity in size with all the beams throughout the entire design. Most likely this was done to decrease construction time.

Appendix A

GENERAL INFORMATION		
Occupancy Type	III	
Seismic Use Group	II	
Site Class	D	
Seismic Design Category	A	
Short period spectral response	S_s	0.10
Spectral response at 1 Sec	S_1	0.04
Maximum short period spectral response	S_{ms}	0.16
Maximum spectral response at 1 sec	S_{m1}	0.10
Design short period spectral response	S_{DS}	0.11
Design spectral response at 1 Sec	S_{D1}	0.06
Response Modification Coefficient	R	5.00
Seismic Response Coefficient	Cs	0.0208
Effective Period	T	1.28
Height Above Grade	h_{nTower}	$h_{nMulti\ Use}$
	256.13	48.16
Base Shear	V_{Tower}	$V_{Multi\ Use}$
	1602.58	221.86
Overturning Moment	M_{Tower}	$M_{Multi\ Use}$
	296396.7	7746.0

TOWER MASS					
Floor	Area (sf)	Slab Thk (ft)	Slab Weight (kips)	Dead Load (psf)	Dead Wt. (kips)
1					
2	1716.47	0.50	123.59	10.00	17.16
3	5149.40	0.67	494.34	20.00	102.99
4	2574.70	0.67	247.17	20.00	51.49
5	5149.40	0.67	494.34	20.00	102.99
6	5149.40	0.67	494.34	20.00	102.99
7	5149.40	0.67	494.34	20.00	102.99
8	5149.40	0.67	494.34	20.00	102.99
9	5149.40	0.67	494.34	20.00	102.99
10	5149.40	0.67	494.34	20.00	102.99
11	5149.40	0.67	494.34	20.00	102.99
12	5149.40	0.67	494.34	20.00	102.99
13	5149.40	0.67	494.34	20.00	102.99
14	5149.40	0.67	494.34	20.00	102.99

15	5149.40	0.67	494.34	20.00	102.99
16	5149.40	0.67	494.34	20.00	102.99
17	5149.40	0.67	494.34	20.00	102.99
18	5149.40	0.67	494.34	20.00	102.99
19	5149.40	0.67	494.34	20.00	102.99
20	5149.40	0.67	494.34	20.00	102.99
21	5149.40	0.67	494.34	20.00	102.99
22	5149.40	0.67	494.34	20.00	102.99
23	5149.40	0.67	494.34	20.00	102.99
24	5149.40	1.00	741.51	30.00	154.48
Roof	2574.70	1.00	370.76	40.00	102.99
			Total kips		Total kips
			11369.88		2385.89

TOWER MASS (2)				
Floor	Column Area (sf)	Col Ht. (ft)	Column Wt (kip)	Floor Wt (kip)
1				
2	93.02	19.66	263.35	404.10
3	1234.50	19.00	3377.60	3974.93
4	1001.18	9.50	1369.62	1668.28
5	2022.86	9.50	2767.28	3364.61
6	2022.86	9.50	2767.28	3364.61
7	2022.86	9.50	2767.28	3364.61
8	2022.86	9.50	2767.28	3364.61
9	2022.86	9.50	2767.28	3364.61
10	2022.86	9.50	2767.28	3364.61
11	2022.86	9.50	2767.28	3364.61
12	2022.86	9.50	2767.28	3364.61
13	2022.86	9.50	2767.28	3364.61
14	2022.86	9.50	2767.28	3364.61
15	2022.86	9.50	2767.28	3364.61
16	2022.86	9.50	2767.28	3364.61
17	2022.86	9.50	2767.28	3364.61
18	2022.86	9.50	2767.28	3364.61
19	2022.86	9.50	2767.28	3364.61
20	2022.86	9.50	2767.28	3364.61
21	2022.86	9.50	2767.28	3364.61
22	2022.86	9.50	2767.28	3364.61
23	2022.86	9.50	2767.28	3364.61
24	2022.86	11.00	3204.22	4100.21
Roof	1011.43	16.50	2403.16	2876.91
			Total kips	Total Mass (kips)
			63196.21	76951.98

TOWER LOADS

Floor	$W_x h_x^k$	h	C_{vx}	k	F_x	M (ft-kip)	Story Shear
1				1.61			kip
2	48849	19.66	0.0002	1.61	0.3	6.1	1602.6
3	1427083	38.66	0.0056	1.61	9.0	349.7	1602.3
4	851392	48.10	0.0034	1.61	5.4	259.6	1593.2
5	2295102	57.60	0.0091	1.61	14.5	837.9	1587.8
6	2934469	67.10	0.0116	1.61	18.6	1248.1	1573.3
7	3631626	76.60	0.0144	1.61	23.0	1763.3	1554.7
8	4383651	86.10	0.0173	1.61	27.8	2392.4	1531.7
9	5188090	95.60	0.0205	1.61	32.9	3143.8	1503.9
10	6042839	105.10	0.0239	1.61	38.3	4025.6	1471.0
11	6946068	114.60	0.0275	1.61	44.0	5045.6	1432.7
12	7896166	124.10	0.0312	1.61	50.1	6211.2	1388.7
13	8891696	133.60	0.0352	1.61	56.4	7529.8	1338.6
14	9931367	143.10	0.0393	1.61	63.0	9008.2	1282.2
15	11014010	152.60	0.0436	1.61	69.8	10653.5	1219.3
16	12138560	162.10	0.0480	1.61	76.9	12472.1	1149.5
17	13304040	171.60	0.0526	1.61	84.3	14470.8	1072.5
18	14509550	181.10	0.0574	1.61	92.0	16655.7	988.2
19	15754256	190.60	0.0623	1.61	99.9	19033.2	896.2
20	17037383	200.10	0.0674	1.61	108.0	21609.3	796.4
21	18358209	209.60	0.0726	1.61	116.4	24390.0	688.4
22	19716057	219.10	0.0780	1.61	125.0	27381.2	572.0
23	21110292	228.60	0.0835	1.61	133.8	30588.7	447.1
24	27747402	239.60	0.1097	1.61	175.9	42140.5	313.2
Roof	21672086	256.10	0.0857	1.61	137.4	35180.4	137.4
	Total			Base Shear		Overturning Moment	
	252830244			V=	1602.6	M=	296396.7

MULTI USE MASS

Floor	Floor Area (sf)	Slab Thk (ft)	Floor wt (kips)	Column Ht.	Column Wt (plf)
1					
2	34365.7	0.7	3299.1	19.7	90.0
3	34365.7	0.7	3299.1	19.0	90.0
Roof	16111.9	45 psf	725.0	9.5	120.0
			Total (kips)		
			7323.3		

MULTI USE MASS (2)

Floor	Dead Load (psf)	No. Columns	Col. Wt. (kips)	Dead wt (kips)	Floor Wt (kips)
1					
2	10.0	38.0	67.3	343.7	3710.0
3	10.0	38.0	65.0	343.7	3707.7
Roof	10.0	14.0	16.0	161.1	902.1
			Total (kips)	Total (kips)	Total (kips)
			148.2	848.4	8319.9

MULTI USE LOADS						
Floor	$W_x h_x^k$	h	C_{vx}	k	F_x	Moment (ft-kip)
1						
2	72939.0	19.66	0.28	1.00	62.3	1224.9
3	143341.4	38.66	0.55	1.00	122.4	4733.7
Roof	43446.0	48.16	0.17	1.00	37.1	1787.3
	Total				Base Shear	Overturning Moment
	259726.4				221.9	7746.0

Appendix B

GENERAL INFO		
Building Category	III	
Importance Factor, I	1.15	
Exposure Category	B	
k_d	0.85	
$k_{zt}=(1=k1k2k3)^2$	1.00	
V (mph)	90.00	
Period, T		
Tower	T_a	2.94
Multi use	T	0.40
C_T	0.02	
h_n	256.13	
x	0.90	
Frequency, n_1	0.34	
North South Length	160.61	
East West Length	95.34	
Building Height, h_n		
Tower	256.13	
Multi use	48.16	

TOWER GUST FACTOR		
	N-S	E-W
L	160.61	95.34
B	95.34	160.61
n_1	0.34	0.34
TYPE	FLEXIBLE	FLEXIBLE
z_{min}	30.00	30.00
c	0.30	0.30
I_z	0.23	0.23
h	129.67	129.67
L_z	534.38	534.38
ℓ	320.00	320.00
z	153.68	153.68
epsilon hat	0.33	0.33
Q	1.00	0.98
g_Q	3.40	3.40
g_v	3.40	3.40
G		
g_r	3.92	3.92
R_h	2.44	2.44
R_B	2.96	2.16
R_L	4.48	6.86
MU_{Rh}	0.00	0.00
MU_{RB}	0.00	0.00
MU_{RL}	0.00	0.00
Beta	0.50	0.50
Vz	2821054.12	2821054.12
b	0.45	0.45
alpha	7.00	7.00
N_1	0.00	0.00
R_n	0.00	0.00
R	0.14	0.14
G_F	0.93	0.92

TOWER					
No. of Stories		24			
Typ. Story Height (ft)		9.5			
Builidng Height (ft)		256.125			
L/B in N-S Direction		1.68			
L/B in E-W Direction		0.59			
h/L in N-S Direction		1.59			
h/L in E-W Direction		2.69			
		$C_{p,windward}$	$C_{p,leeward}$	$C_{p,side\ wall}$	Gust Factor
N-S Direciton:		0.80	-0.42	-0.70	0.93
E-W Direciton:		0.80	-0.23	-0.70	0.92
Gcpi	Enlosed +/-	0.18			
Internal Pressure +/-		4.71			

GENERAL INFO		
Building Cate	III	
Importance F	1.15	
Exposure Cat	B	
k_d	0.85	
k_{zt}=(1=k1k2k	1.00	
V (mph)	90.00	
Period, T		
Tower	T_a	2.94
Multi use	T	0.40
C_T	0.02	
h_n	256.13	
x	0.90	
Frequency, n	0.34	
North South L	160.61	
East West Le	95.34	
Building Height, h_n		
Tower	256.13	
Multi use	48.16	

MULTI USE GUST FACTOR			
	N-S	E-W	
L	199.33	170.67	
B	170.67	199.33	
n_1	2.50	2.50	
TYPE	RIGID	RIGID	G_F=0.85
z_{min}	30.00	30.00	
c	0.30	0.30	
I_z	0.31	0.31	
h	129.67	129.67	
L_z	306.14	306.14	
ℓ	320.00	320.00	
z	28.90	28.90	
epsilon hat	0.33	0.33	
Q	1.00	0.97	
g_Q	3.40	3.40	
g_v	3.40	3.40	
G	0.92	0.91	
g_r	4.40	4.40	
R_h	#VALUE!	#VALUE!	
R_B	#VALUE!	#VALUE!	
R_L	#VALUE!	#VALUE!	
MU_{Rh}	#VALUE!	#VALUE!	
MU_{RB}	#VALUE!	#VALUE!	
MU_{RL}	#VALUE!	#VALUE!	
Beta	0.50	0.50	
Vz			
b	0.45	0.45	
alpha	7.00	7.00	
N_1	#VALUE!	#VALUE!	
R_n	#VALUE!	#VALUE!	
R	#VALUE!	#VALUE!	
G_F	FALSE	FALSE	

MULTI USE	
No. of Stories	4
Typ. Story Height (ft)	19
Builidng Height (ft)	48.16
L/B in N-S Direction	1.17
L/B in E-W Direction	0.86
h/L in N-S Direction	0.24
h/L in E-W Direction	0.28

		$C_{p,windward}$	$C_{p,leeward}$	$C_{p,side\ wall}$	Gust Factor
N-S Direciton:		0.80	-0.50	-0.70	0.85
E-W Direciton:		0.80	-0.50	-0.70	0.85
Gcpi	Enlosed +/-	0.18			
Internal Pressure +/-		2.96			

TOWER				
Floor	h(above grade)	Floor height	k_Z	q_Z
1	0.00			
2	19.66	19.66	0.62	12.57
3	38.66	19.00	0.76	15.40
4	48.10	9.50	0.81	16.42
5	57.60	9.50	0.85	17.23
6	67.10	9.50	0.89	18.04
7	76.60	9.50	0.93	18.85
8	86.10	9.50	0.96	19.46
9	95.60	9.50	0.99	20.07
10	105.10	9.50	1.04	21.08
11	114.60	9.50	1.04	21.08
12	124.10	9.50	1.09	22.09
13	133.60	9.50	1.09	22.09
14	143.10	9.50	1.13	22.90
15	152.60	9.50	1.13	22.90
16	162.10	9.50	1.17	23.72
17	171.60	9.50	1.17	23.72
18	181.10	9.50	1.17	23.72
19	190.60	9.50	1.20	24.32
20	200.10	9.50	1.20	24.32
21	209.60	9.50	1.22	24.73
22	219.10	9.50	1.24	25.13
23	228.60	9.50	1.26	25.54
24	239.60	11.00	1.28	25.94
Roof	256.10	16.46	1.29	26.15

Tower Pressures (psf)					
NS windward	NS leeward	NS side wall	EW windward	EW leeward	EW side wall
9.35	-10.19	-8.18	9.25	-5.57	-8.09
11.46	-10.19	-10.03	11.34	-5.57	-9.92
12.22	-10.19	-10.69	12.08	-5.57	-10.57
12.82	-10.19	-11.22	12.68	-5.57	-11.10
13.42	-10.19	-11.74	13.28	-5.57	-11.62
14.02	-10.19	-12.27	13.87	-5.57	-12.14
14.48	-10.19	-12.67	14.32	-5.57	-12.53
14.93	-10.19	-13.06	14.77	-5.57	-12.92
15.68	-10.19	-13.72	15.52	-5.57	-13.58
15.68	-10.19	-13.72	15.52	-5.57	-13.58
16.44	-10.19	-14.38	16.26	-5.57	-14.23
16.44	-10.19	-14.38	16.26	-5.57	-14.23
17.04	-10.19	-14.91	16.86	-5.57	-14.75
17.04	-10.19	-14.91	16.86	-5.57	-14.75
17.64	-10.19	-15.44	17.45	-5.57	-15.27

17.64	-10.19	-15.44	17.45	-5.57	-15.27
17.64	-10.19	-15.44	17.45	-5.57	-15.27
18.10	-10.19	-15.83	17.90	-5.57	-15.66
18.10	-10.19	-15.83	17.90	-5.57	-15.66
18.40	-10.19	-16.10	18.20	-5.57	-15.93
18.70	-10.19	-16.36	18.50	-5.57	-16.19
19.00	-10.19	-16.63	18.80	-5.57	-16.45
19.30	-10.19	-16.89	19.10	-5.57	-16.71
19.45	-10.19	-17.02	19.24	-5.57	-16.84

Forces (k)		**Shears (k)**		**Moments (ft-k)**	
N/S	E/W	N/S	E/W	Moment	Moment
				NS	EW
61.69	27.77	1065.64	515.59	1212.85	545.93
66.06	30.62	1003.95	487.82	1255.19	581.78
34.18	15.99	937.89	457.20	324.73	151.86
35.10	16.53	903.71	441.22	333.47	157.00
36.02	17.07	868.61	424.69	342.21	162.13
36.94	17.61	832.58	407.62	350.96	167.27
37.63	18.01	795.64	390.02	357.52	171.12
38.32	18.42	758.01	372.00	364.07	174.97
39.47	19.09	719.68	353.59	375.00	181.39
39.47	19.09	680.21	334.49	375.00	181.39
40.62	19.77	640.74	315.40	385.93	187.80
40.62	19.77	600.11	295.63	385.93	187.80
41.54	20.31	559.49	275.86	394.68	192.94
41.54	20.31	517.94	255.55	394.68	192.94
42.47	20.85	476.40	235.24	403.42	198.07
42.47	20.85	433.93	214.39	403.42	198.07
42.47	20.85	391.47	193.54	403.42	198.07
43.16	21.26	349.00	172.69	409.98	201.92
43.16	21.26	305.85	151.44	409.98	201.92
43.62	21.53	262.69	130.18	414.35	204.49
44.08	21.80	219.07	108.66	418.72	207.06
44.54	22.07	175.00	86.86	423.09	209.63
52.10	25.86	130.46	64.80	573.11	284.49
78.36	38.93	78.36	38.93	1289.82	640.86
Total					
1065.64	515.59			12001.55	5780.90

MULTI USE				
Floor	h(above grade)	Floor height	k_z	q_z
1	0			
2	19.66	19.66	0.62	12.57
3	38.66	19.00	0.76	15.40
4	48.16	9.50	0.81	16.42

M-U Pressures (psf)						
Floor	NS windward	NS leeward	NS side wall	EW windward	EW leeward	EW side wall
1						
2	8.55	-5.34	-7.48	8.55	-5.34	-7.48
3	10.48	-6.55	-9.17	10.48	-6.55	-9.17
4	11.16	-6.98	-9.77	11.16	-6.98	-9.77

M-U Forces (k)			Shears (k)	
Floor	N/S	E/W	N/S	E/W
1				
2	54.42	46.59	54.42	46.59
3	64.47	55.20	118.89	101.79
4	34.36	29.41	153.24	131.21
Total	153.24	131.21	326.55	279.59

APPENDIX C

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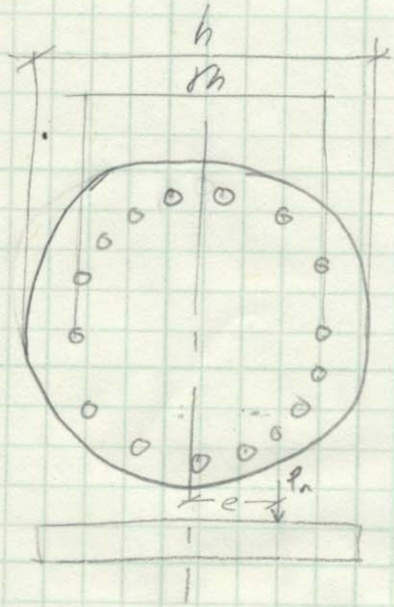
COLUMN R5 GROUND FLOOR



DETAILS

30 in Ø

16 #11 BARS V.R.

$f'_c = 10$ ksi

$f_y = 60$ ksi (ASTM A618)

$A_s = 16(1.56)$

$= 24.96 \text{ in}^2$

$\varepsilon_y = 0.00207$

$A_g = \frac{\pi 30^2}{4} = 706.8 \text{ in}^2$

PURE AXIAL

$$P_o = 0.85 f'_c (A_c - \Sigma A_{si}) + \Sigma A_{si} f_{si}$$

$$= 0.85(10)\left(\frac{\pi (30)^2}{4} - 24.96\right) + 24.96(60)$$

$$= 7294 \text{ kips}$$

$$\phi P_n = 0.70(7294) = 5106 \text{ kips}$$

$$\gamma = \frac{30-5}{30} = 0.83$$

CHECK FOR MAX MOMENT

$$e = \frac{h}{2} = 15$$

$$\rho = \frac{A_s}{A_g} = \frac{24.96}{706.8} = 0.035$$

R = 0.17 (DESIGN AIDS)

$$R = \frac{P_n e}{f'_c A_g h} = M_u$$

$$M_u = R(f'_c) A_g h = 0.17(10)(706.8)(30)$$

$$= 36046 \text{ in-k} = 3004 \text{ ft-k}$$

$$M_n = 0.70(3004) = 2103 \text{ ft-kip}$$

COLUMN CHECK

CHECK $f_s = \frac{1}{2} f_y$

$K_n = 0.65 = \frac{P_u}{\phi f_c' A_g}$

$P_u = 0.65(0.70)(10)(706.8)$

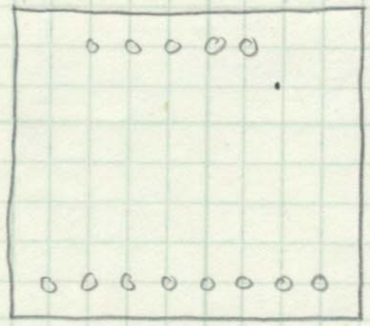
$= 3216$ kips

$R_n = 0.16 = \frac{M_u}{\phi f_c' A_g h}$

$M_u = 0.16(0.70)(10)(706.8)(30)$

$= 1979$ ft-kips

BEAM 2B3



$d = 21.5''$

$b = 36''$

$T = C$

$A_s f_y = A_s' \frac{0.003}{c}(c - d')E_s + 0.85 f_c' b \beta_1 c$

$8(60) = (5)\frac{0.003}{c}(c - 2.5)(29000) + 0.85(5)(36)(0.8)c$

$480 = 435\frac{(c - 2.5)}{c} + 122.4c$

$480c = 435c - 1087.5 + 122.4c^2$

$0 = 122.4c^2 - 45c - 1087.5$

$c = 3.17$ in.

$f_s' = \frac{0.003}{c}(c - 2.5)29000$

$= \frac{0.003}{3.17}(3.17 - 2.5)29000$

$= 18.4$ ksi

NOMINAL MOMENT

$M_n = 0.85 f_c' b \beta_1 c(d - \beta_1 c/2) + A_s' f_s'(d - d')$

$= 0.85(5)(22.5)(0.8)(3.17)\left(22.5 - \frac{3.17(0.8)}{2}\right) + 5(18.4)(22.5 - 2.5)$

$M_n = 6988$ in-k $= 582$ ft-kip

$\varepsilon_t = 0.003\left(\frac{d_t - c}{c}\right) = 0.003\left(\frac{21.5 - 3.17}{3.17}\right)$

$= 0.0173 > 0.005 \therefore \phi = 0.9$ ok

$\phi M_n = 0.9(582) = 524$ ft-k

BEAM 2B3

SHEAR

#4 BARS AT 10", $A_v = 2(0.2) = 0.4\ in^2$

$V_c = 2\sqrt{f'_c}\, b_w d = 2\sqrt{5000}\,(36)(21.5)$

$= 109.5\ kip$

$\phi V_n = \frac{1}{2}\phi V_c = \frac{1}{2}(0.75)(109.5)$

$= 41.0\ kip$

$V_s = \dfrac{A_v f_y d}{s} = \dfrac{(0.4)(60)(21.5)}{10}$

$= 51.6\ kip$

$\phi V_s = 0.75 V_s = 38.7\ k$

$\phi V_n = \phi V_n + \phi V_s$

$= 79.7\ kips$

$A_{v_{min}} = \dfrac{50 b_w s}{f_y} = \dfrac{50(36)(10)}{60000} = 0.3\ in^2 < A_v = 0.4\ in^2$

$_{MAX} = \dfrac{0.75\sqrt{f'_c}\, b_w s}{f_y} = \dfrac{0.75\sqrt{5000}(21.5)(10)}{60000} = 0.19\ in^2$

BEAM 2B3

TRIBUTARY AREA

* ASSUME A SQUARE OF AVE WIDTH/LENGTH. THIS WILL GIVE A CONSERVATIVE LOADING CONDITION. CONC = 150 pcf.

$$\text{WIDTH} = [(32 + 11)/2]/2 \doteq 11'$$

$$\text{LENGTH} = 32'$$

$$T.A. = 32(16)$$
$$= 512 \text{ sf.}$$

LOADS

BEAM SELF WT

$$W_B = \frac{(36 \times 24)\text{in}^2}{144\text{ in}^2}(150\text{ pcf}) = 0.90\text{ klf}$$

SLAB WT

$$W_s = \left(\frac{7.5}{12}\right)(11)(150\text{ pcf}) - \left(\frac{7.5}{12}\right)\left(\frac{36}{12}\right)150$$
$$= 0.75\text{ klf}$$

DEAD/LIVE

* LOADS ARE 10 psf DEAD AND 100 PSF LIVE

$$W = 1.2(10)(11) + 1.6(100)(11) = 1.892\text{ klf}$$

$$W_u = 3.54\text{ klf}$$

$$M_u = \frac{3.54(32)^2}{8} = 453\text{ ft kips} < \phi M_n = 524\text{ ft-kips} \quad \underline{\text{ok}}$$

$$V_u = \frac{w_u l}{2} = \frac{3.54(32)}{2} = 57.0\text{ kip} < \phi V_n = 79\text{ kips} \quad \underline{\text{ok}}$$

SHEAR WALL

SHEAR WALL	l (ft)	DIRECTION	THICKNESS
1	25'-8"	EW	12"
2	25'-8"	EW	12"
3	34'-10"	NS	12"
4	10'-7'	NS	12"

RELATIVE STIFFNESS

$$k_1 = \frac{25.66}{25.66} = 1$$

$$k_2 = 1$$

$$k_3 = \frac{34.83}{10.58} = 3.29$$

$$k_4 = 1$$

BASE SHEAR

$V_B = 1603$ kip

OVERTURNING MOMENT

$M = 296400$ kip

CHECK EAST WEST SHEAR

$$F_{EW} = \frac{k_i}{\Sigma k}(V_B) = \frac{2.43}{2(2.43)}(1603) = 803\ k = F_{S1} = F_{S2}$$

SHEAR WALL 1/2 AT GROUND LEVEL

$f'_c = 10$ ksi

$l = 25.66$ ft

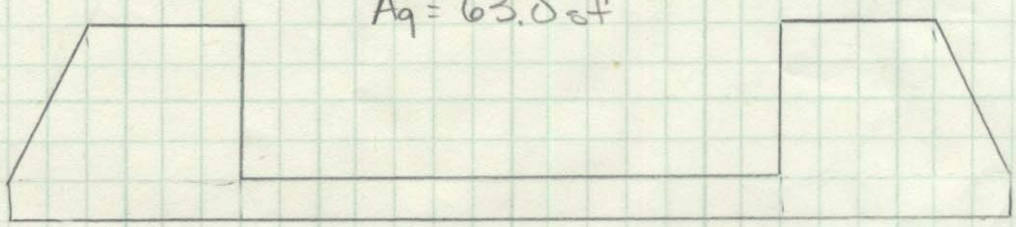
$f_y = 60$ ksi (ASTM A615)

$h_w = 271$ ft

* DONE BY AUTOCAD CALC TO ACTUAL SIZE

SHEAR WALL SHAPE* 1&2

$A_g = 63.0$ sf



SHEAR WALL

$$V_u \le A_{cv}\left(\alpha_c \sqrt{f'_c} + \rho_t f_y\right)$$

$$\frac{h_w}{l_w} = \frac{256}{25.66} = 9.98 > 2 \quad \therefore \alpha_c = 2.0$$

$$A_{cv} = 12(25.66)(12) = 3695.0\ in^2$$

$$A_{sl} = (4)(1.0) = 4.0\ in^2/$$

$$\rho = \frac{A_{sl}}{12t} = \frac{4.0}{12(12)} = 0.0278$$

$$V_n = 3695\left[2.0\sqrt{10000} + 0.0278(60000)\right]$$

$$= 6900\ kip$$

$$\phi V_n = 0.6(6900)$$

$$= 4141\ kip > 803k \quad \underline{ok}$$

LATERAL DISTRIBUTION

EW

$$F_1 = F_2 = \frac{k_i}{\Sigma k_i} = \frac{k}{2k}(1603) = 802.5^k$$

NS

$$F_3 = \frac{k}{\Sigma k}V = \frac{3.29}{4.29}(1603) = 1229.3^k$$

$$F_4 = \frac{k}{\Sigma k}V = \frac{1}{4.29}(1603) = 373.7^k$$

PERCENT RESISTANCE

$$F_{3(\%)} = \frac{1229.3}{1603}(100) = 76.7\%$$

$$F_{4(\%)} = \frac{373.7}{1603}(100) = 23.3\%$$

} E-W

$$F_{1(\%)} = F_{2(\%)} = 50.0\% \longrightarrow \text{N-S}$$

SHEAR WALL | METHOD 2

<u>BASE SHEAR</u>

SEISMIC 1603 k ← governs

WIND 985 k

$V_n = 10\sqrt{f'_c}\, h\, d$

$h = 19.66'$

$l = 25.66$

$d = 0.8l = 0.8(25.66) = 20.53$

$V_n = 10\sqrt{10000}\,(12'')(20.53 \times 12'')$

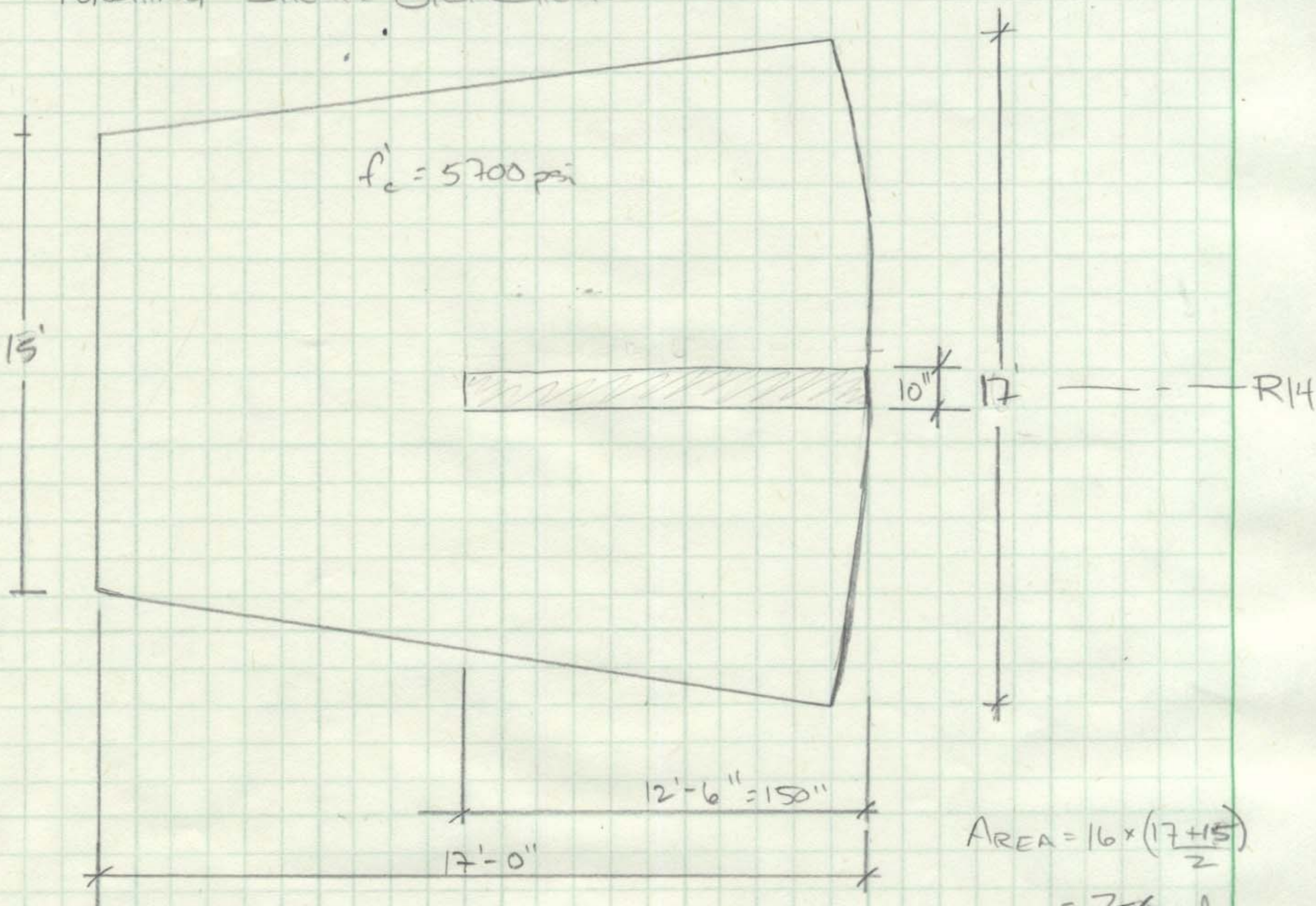
$= 2956\text{ k}$

$\phi V_n = 0.80(2956)$

$= 2365\text{ k} > V_{EW} = \frac{1603}{2} = 802\text{ k}$

SLAB

PUNCHING SHEAR SPOT CHECK



$AREA = 16 \times \left(\frac{17+15}{2}\right)$

$= 256$ sf.

EXTERIOR WALL-COLUMN 6TH FLOOR ALONG LINE R-14. 2 WAY SLAB w/ REINFORCING BOTH WAYS.

$\alpha_s = 30$

SUPER IMPOSED DEAD = 20 PSF (FROM E.O.R.)

LIVE LOAD = 40 PSF

REDUCTION = $\left(.25 + \frac{15}{\sqrt{4(256)}}\right) = 0.71$

$LL = 40(0.71)$

$= 28.4$ PSF

$d = 7.5" - 1" = 6.5$ in.

$W_u = 1.2(20) + 1.2\left(\frac{7.5}{12}\right)150 + 1.6(28.4)$

$= 181.9$ PSF

$V_u = W_u A = 181.9(256)$

$= 46.6$ k

SLAB

$$b_o = 2\left(150 + \frac{6.5}{2}\right) + \left(10 + \frac{6.5}{2}\right)$$
$$= 319.75 \text{ in.}$$

$$\beta_c = \frac{150}{10} = 15 \gg 2,$$

$$V_c = \left(2 + \frac{4}{\beta_c}\right)\sqrt{f'_c}\, b_o d$$

$$= \left(2 + \frac{4}{15}\right)\sqrt{5700}\,(319.75)(6.5)$$

$$= 356^k$$

$$V_c = 4\sqrt{f'_c}\, b_o d = 4\sqrt{5700}\,(319.75)(6.5) = 627^k$$

$$V_c = \left(\frac{\alpha_s}{b_o/d} + 2\right)\sqrt{f'_c}\, b_o d$$

$$= \left(\frac{30}{\left(\frac{319.75}{6.5}\right)} + 2\right)\sqrt{5700}\,(319.75)(6.5) = 95.7^k$$

$$\phi V_c = 0.75(95.7)$$

$$= 71.8^k > V_u = 46.6^k \ \checkmark \text{ok}$$

Snow Load Check:

Snow Loads	
GROUND	
p_g	35.00
C_e	1.00
C_t	1.00
I	1.10
20(I)	22.00
p_f	26.95
DRIFT	
l_u	100.00
h_d	3.66
γ	18.55
p_d	67.89

Appendix D

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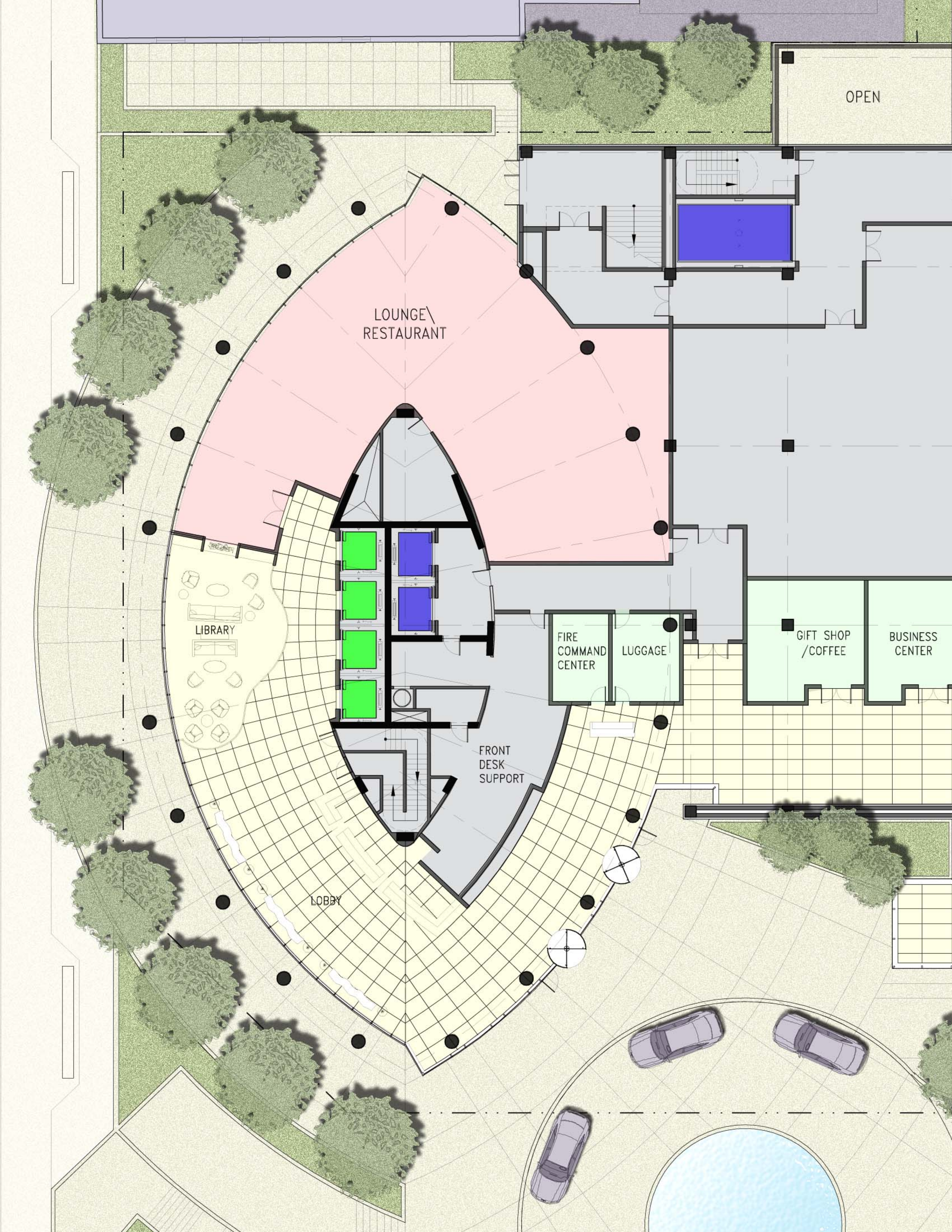
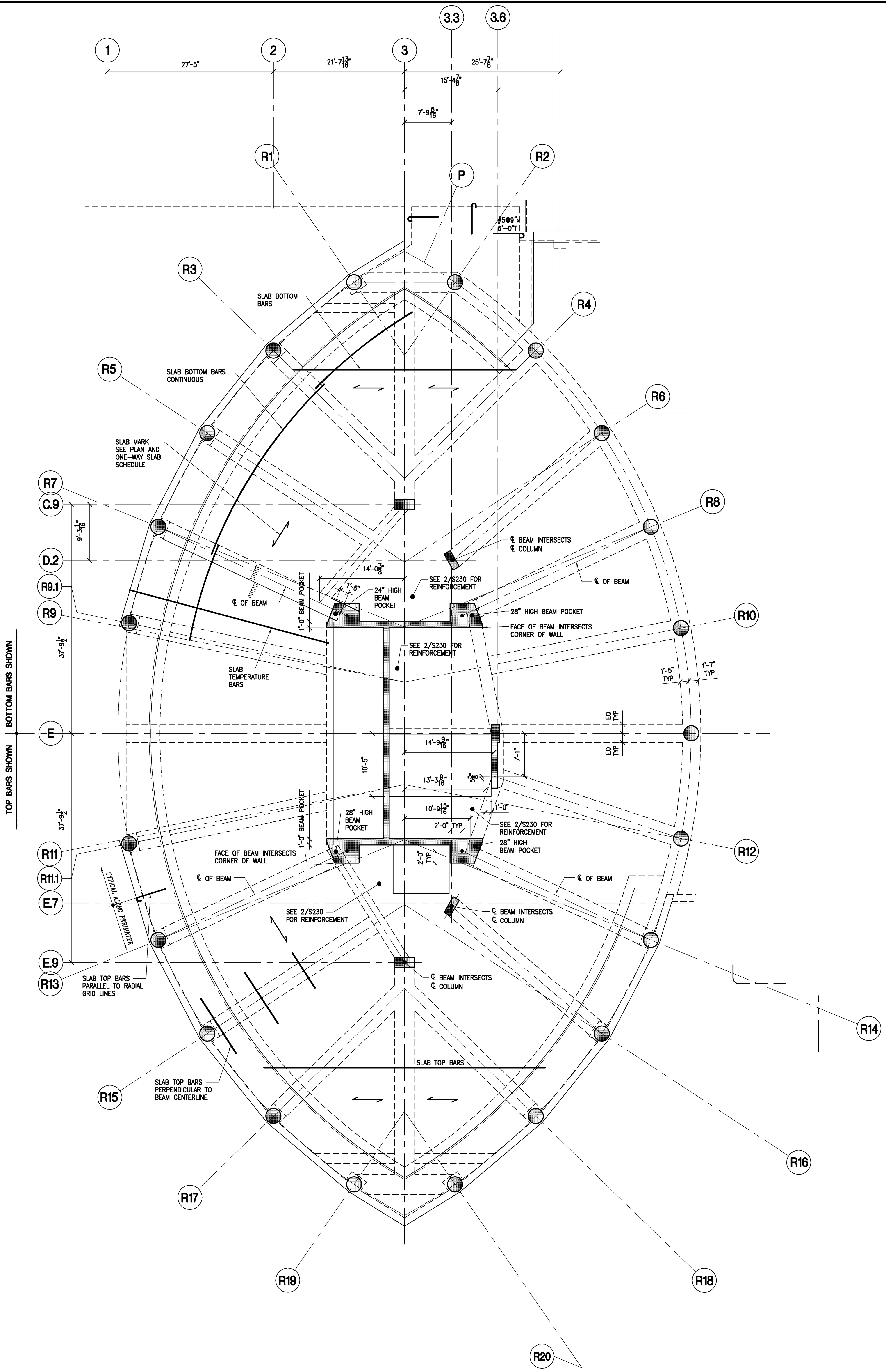

OPEN
LOUNGE\
RESTAURANT
LIBRARY
FIRE
COMMAND
CENTER
LUGGAGE
GIFT SHOP
/COFFEE
BUSINESS
CENTER
FRONT
DESK
SUPPORT
LOBBY



2 SLAB REINFORCEMENT AND BEAM LAYOUT PLAN

SCALE: 1/8"=1'-0"

1. THE REINFORCEMENT INFORMATION ON THIS DRAWING APPLIES TO FLOORS: GROUND, 2ND, 2ND-MEZZ, 3RD, 3RD-LOW, 4TH, 5TH
2. SEE FRAMING PLANS AND TYPICAL DETAILS FOR ADDITIONAL INFORMATION.

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15	24 OCT 05	TOWER CONCRETE BID PACKAGE

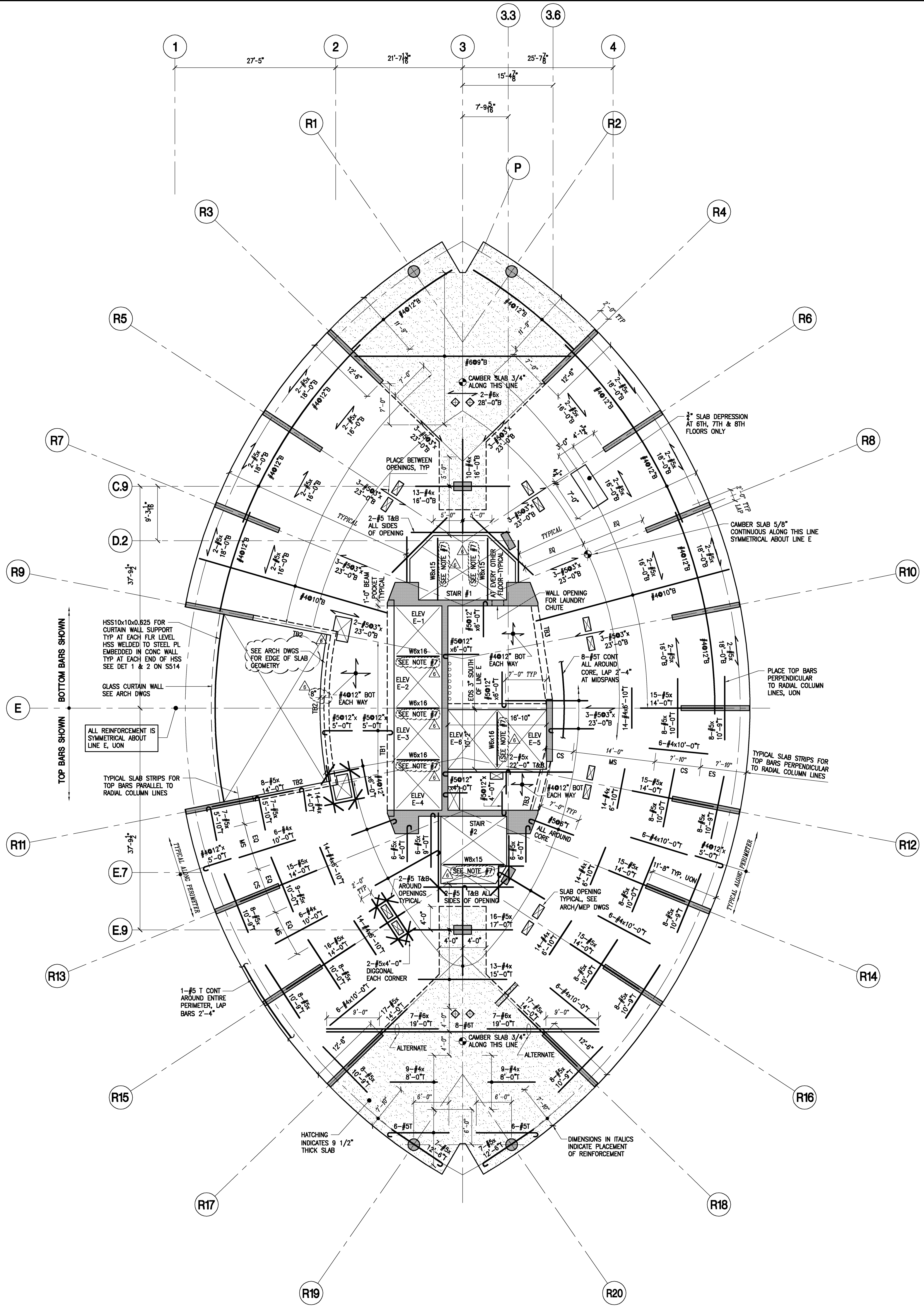
SHEET TITLE:

SLAB REINFORCEMENT
LAYOUT PLAN
LEVELS 1-5

PROJECT ELEVATION = 0.0" = GRAND RAPIDS + 615.0"

SEAL:

SCALE:	AS SHOWN
DRAWN BY:	
CHECKED BY:	
PROJECT NO.:	CC4467.00
DRAWING NUMBER:	S267



2 6TH-22ND FLOOR FRAMING PLAN

SCALE: 1/8"=1'-0"

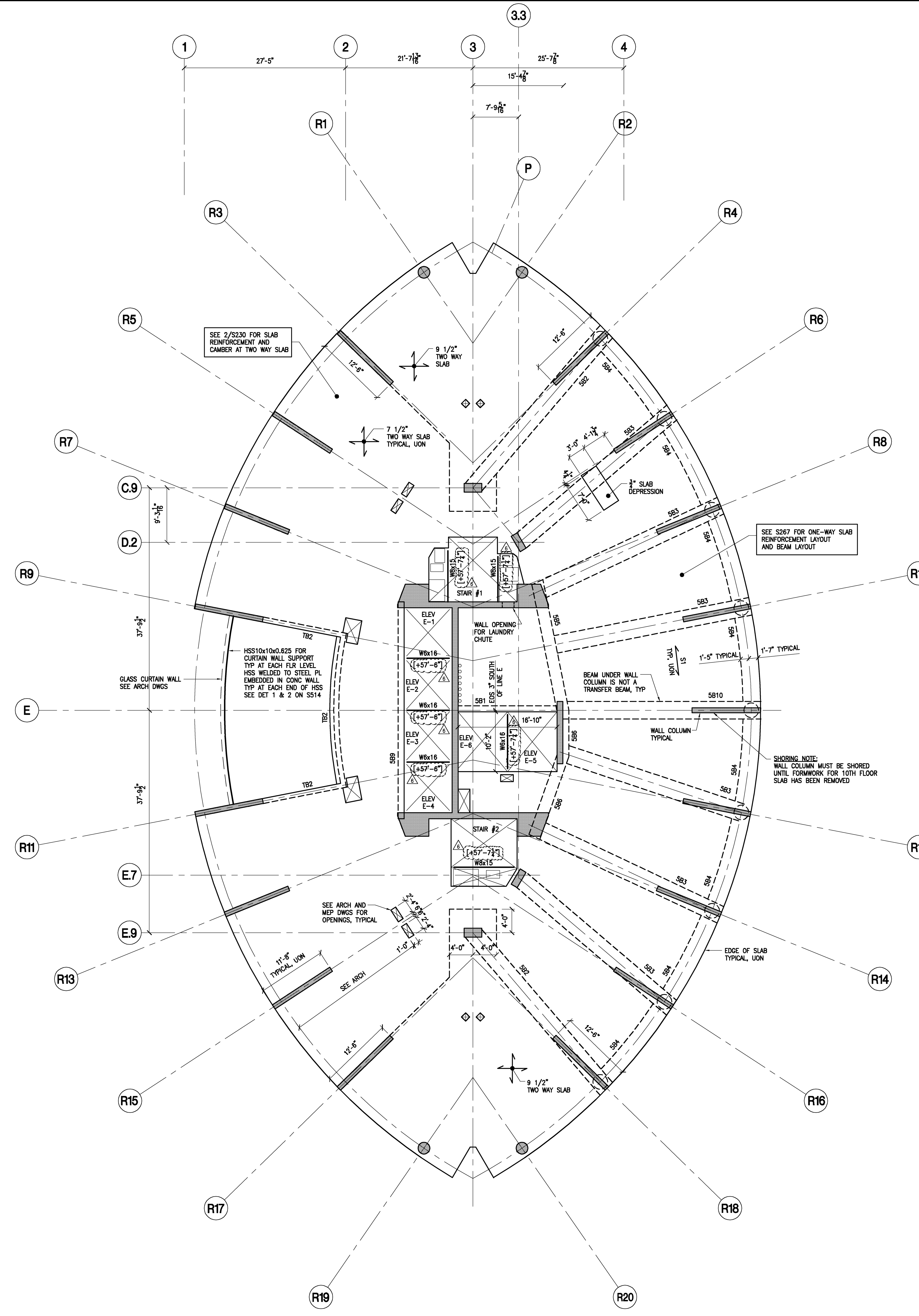
1. T/SLAB EL: SEE LIST ON THIS DRAWING
2. 7 1/2"THICK SLAB, UON, NORMAL WEIGHT CONCRETE
3. CONCRETE STRENGTH f'c = 5700 PSI AT 6TH - 8TH FLOORS
   f'c = 5000 PSI, TYPICAL
4. BOTTOM BARS SHOWN THUS ⟵⟶ ARE IN ADDITION TO TYPICAL CONTINUOUS BOTTOM BARS
5. BAR PLACEMENT SEQUENCE:
   1. BOTTOM BARS PARALLEL TO RADIAL COLUMN LINES
   2. BOTTOM BARS PERPENDICULAR TO RADIAL COLUMN LINES
   3. TOP BARS PERPENDICULAR TO RADIAL COLUMN LINES
   4. TOP BARS PARALLEL TO RADIAL COLUMN LINES
6. CLEAR COVER TO TOP AND BOTTOM BARS = 3/4"
7. T/WB EL AT ELEVATORS E1-E4 = 2" BELOW T/SLAB EL
   T/WB EL AT ELEVATORS E5-E6 = 3/4" BELOW T/SLAB EL
   T/WB EL AT STAIRS #1 AND #2 = 3/4" BELOW T/SLAB EL

T/SLAB ELEVATIONS:

6TH FLOOR	+67'-2"
7TH FLOOR	+76'-8"
8TH FLOOR	+86'-2"
9TH FLOOR	+95'-8"
10TH FLOOR	+105'-2"
11TH FLOOR	+114'-8"
12TH FLOOR	+124'-2"
13TH FLOOR	+133'-8"
14TH FLOOR	+143'-2"
15TH FLOOR	+152'-8"
16TH FLOOR	+162'-2"
17TH FLOOR	+171'-8"
18TH FLOOR	+181'-2"
19TH FLOOR	+190'-8"
20TH FLOOR	+200'-2"
21ST FLOOR	+209'-8"
22ND FLOOR	+219'-2"

REFERENCE:

1. SEE DRAWING S001 FOR GENERAL NOTES.
2. SEE DRAWING S400 FOR CONCRETE COLUMN DETAILS.
3. SEE DRAWINGS S401 & S402 FOR CONCRETE WALL DETAILS.
4. SEE DRAWINGS S403 & S404 FOR CONCRETE SLAB DETAILS.
5. SEE DRAWINGS S405 & S405A FOR CONCRETE BEAM DETAILS.



1 5TH FLOOR FRAMING PLAN

SCALE: 1/8"=1'-0"

1. T/SLAB EL +57'-8", UON
2. CONCRETE STRENGTH, f'c = 5700 PSI

REFERENCE:

1. SEE DRAWING S001 FOR GENERAL NOTES.
2. SEE DRAWING S400 FOR CONCRETE COLUMN DETAILS.
3. SEE DRAWINGS S401 & S402 FOR CONCRETE WALL DETAILS.
4. SEE DRAWINGS S403 & S404 FOR CONCRETE SLAB DETAILS.
5. SEE DRAWINGS S405 & S405A FOR CONCRETE BEAM DETAILS.

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15	24 OCT 05	TOWER CONCRETE BID PACKAGE
5	20 MAY 05	REVISED DESIGN DEVELOPMENT
3	29 APR 05	DESIGN DEVELOPMENT
2	15 APR 05	IN-PROGRESS DESIGN DEVELOPMENT
1	10 DEC 04	SCHEMATIC DESIGN

SHEET TITLE:

5TH AND 6TH-22ND FLOOR FRAMING PLANS

PROJECT ELEVATION = 0.0" = GRAND RAPIDS + 613.0"

SEAL:

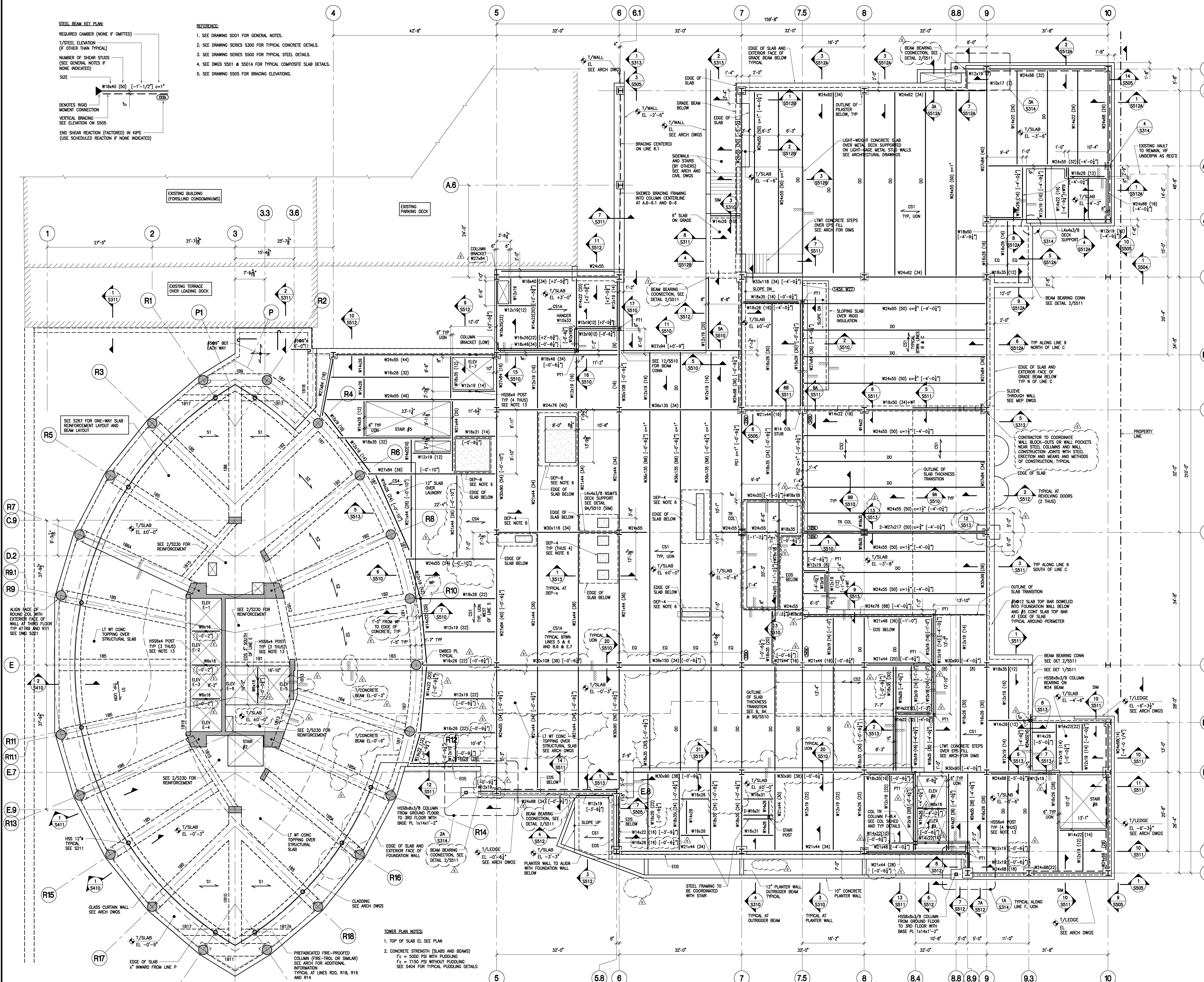
SCALE:	AS SHOWN
DRAWN BY:	
CHECKED BY:	
PROJECT NO.:	CC4467.00
DRAWING NUMBER:	S230

STEEL BEAM KEY PLAN:

- REQUIRED CAMBER (NONE IF OMITTED)
- T/STEEL ELEVATION (IF OTHER THAN TYPICAL)
- NUMBER OF SHEAR STUDS (SEE GENERAL NOTES IF NONE INDICATED)
- SIZE
- W18x40 (50) [-1'-1/2"] c=1"
- DENOTES RIGID MOMENT CONNECTION
- VERTICAL BRACING SEE ELEVATION ON S505
- END SHEAR REACTION (FACTORED) IN KIPS (USE SCHEDULED REACTION IF NONE INDICATED)

REFERENCE:

1. SEE DRAWING S001 FOR GENERAL NOTES.
2. SEE DRAWING SERIES S300 FOR TYPICAL CONCRETE DETAILS.
3. SEE DRAWING SERIES S500 FOR TYPICAL STEEL DETAILS.
4. SEE DWGS S501 & S501A FOR TYPICAL COMPOSITE SLAB DETAILS.
5. SEE DRAWING S505 FOR BRACING ELEVATIONS.



TOWER PLAN NOTES:

1. TOP OF SLAB EL SEE PLAN
2. CONCRETE STRENGTH (SLABS AND BEAMS)
   f'c = 5000 PSI WITH PUDDLING
   f'c = 7150 PSI WITHOUT PUDDLING
   SEE S404 FOR TYPICAL PUDDLING DETAILS

1 GROUND FLOOR FRAMING PLAN

SCALE: 1/8"=1'-0"

LOW RISE PLAN NOTES:

1. TOP OF SLAB EL +0'-0" (GRAND RAPIDS +615.0'), UON
2. TOP OF STEEL EL = T/SLAB EL MINUS SLAB THICKNESS, UON
3. ⟷ INDICATES DECK SPAN DIRECTION.
4. CS1 INDICATES 3" COMPOSITE METAL DECK, 20 GAGE MIN WITH 3 1/4" LIGHTWEIGHT CONCRETE TOPPING SLAB f'c=4000 PSI, REINFORCED WITH WWF 6x6-W2.1xW2.1 TOTAL SLAB THICKNESS: 6 1/4"
5. CS2 INDICATES 3" COMPOSITE METAL DECK, 16 GAGE MIN WITH 9" NORMAL WEIGHT CONCRETE TOPPING SLAB f'c=4000 PSI, REINFORCED WITH WWF 6x6-W2.9xW2.9 TOTAL SLAB THICKNESS: 12" METAL DECK TO BE SHORED
6. DEP-x INDICATES SLAB DEPRESSION, VALUE "x" INDICATES DEPTH OF DEPRESSION IN INCHES (8" OR 4") COMPOSITE SLAB AT DEPRESSION IS SIMILAR TO TYPE CS1 WITH 3" COMPOSITE DECK, 18 GAGE MIN, SEE DET 1/S513 CONTRACTOR TO COORDINATE SIZE AND LOCATION WITH ARCH DWGS AND WITH EQUIPMENT REQUIREMENTS.
7. SEE S201 FOR PIERS/PILASTERS AND GRADE BEAMS
8. TR COL INDICATES COLUMN TRANSFER, SEE TYPICAL DETAILS
9. CS1A INDICATES COMPOSITE SLAB SAME AS CS1 WITH 18 GAGE MIN
10. CS4 INDICATES 3" COMPOSITE METAL DECK, 16 GAGE MIN WITH 7" NORMAL WEIGHT CONCRETE TOPPING SLAB f'c=4000 PSI, REINFORCED WITH #7@12"B AND #5@6"T, SEE DET 11/S501 TOTAL SLAB THICKNESS: 10" METAL DECK TO BE SHORED
11. PT1 INDICATES W10x33 POST WITH BASE PL 3/4x10x1'-0" WITH 4-3/4"ø A325 BOLTS
12. PGx INDICATES PLATE GIRDER. REFER TO SHEET S507 FOR PLATE GIRDER SCHEDULE AND DETAILS
13. HSS6x4 POST IS PROVIDED FOR SUPPORT OF ELEVATOR GUIDE RAILS. EXACT NUMBER AND LOCATION OF POSTS TO BE DETERMINED BASED ON ELEVATOR REQUIREMENTS. CONTRACTOR TO COORDINATE WITH ELEVATOR MANUFACTURER. SEE DETAIL

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15	24 OCT 05	TOWER CONCRETE BID PACKAGE
4 (triangle)	23 SEPT 05	BID ADDENDUM #4 -STRUCTURAL STEEL & FOUNDATIONS
2 (triangle)	03 AUG 05	BID ADDENDUM #2 - FOUNDATION AND SITE UTILITIES
9	03 AUG 05	STRUCTURAL STEEL BID PACKAGE
1 (triangle)	01 JULY 05	BID ADDENDUM #1
6	17 JUNE 05	FOUNDATION AND SITE UTILITIES BID PACKAGE
5	20 MAY 05	REVISED DESIGN DEVELOPMENT
3	29 APR 05	DESIGN DEVELOPMENT
2	15 APR 05	IN-PROGRESS DESIGN DEVELOPMENT
1	10 DEC 04	SCHEMATIC DESIGN

SHEET TITLE:

GROUND FLOOR FRAMING PLAN

PROJECT ELEVATION + 0.0' = GRAND RAPIDS + 615.0'

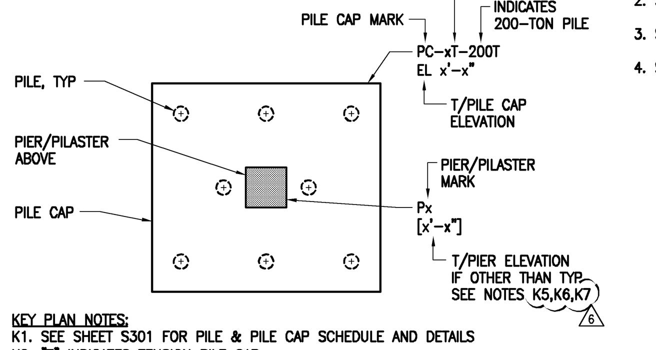
SEAL:

SCALE: AS SHOWN
DRAWN BY:
CHECKED BY:
PROJECT NO.: CC4467.00

DRAWING NUMBER:

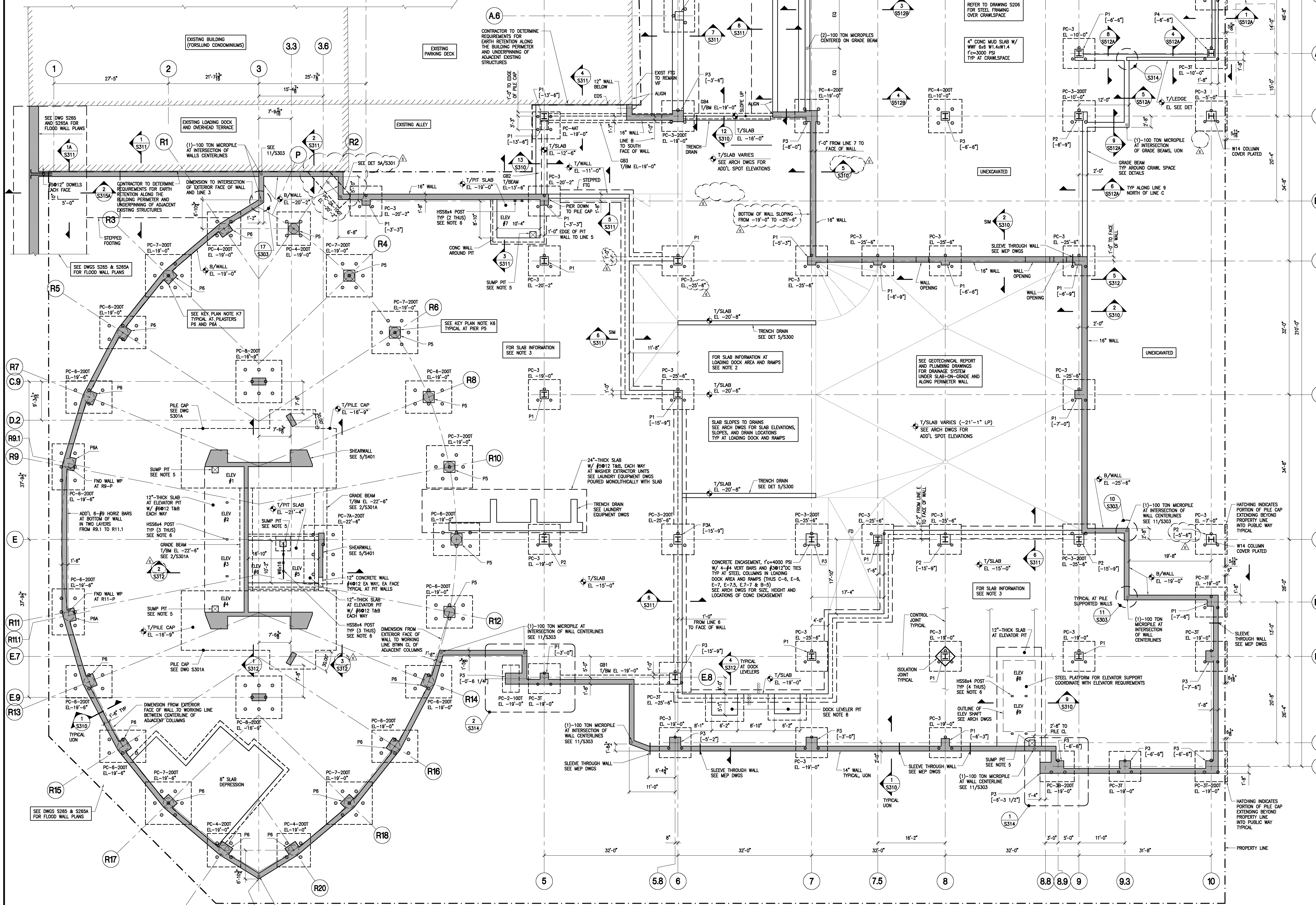
S206

KEY PLAN FOR MICROPILE, PILE CAP, AND PIER:



KEY PLAN NOTES:
K1. SEE SHEET S301 FOR PILE & PILE CAP SCHEDULE AND DETAILS
K2. "T" INDICATES TENSION PILE CAP
K3. 200T INDICATES 200-TON MICROPILE
K4. SEE SHEET S303 FOR TYPICAL PIER/PILASTER DETAILS.
K5. T/PIER EL 1'-6" BELOW T/SLAB TYP, UON
K6. T/PIER P5 EL = B/SLAB EL
K7. T/PILASTER P6 & P6A EL = B/BEAM EL AT GROUND FLR

REFERENCE:
1. SEE DRAWING S001 FOR GENERAL NOTES.
2. SEE DRAWING SERIES S300 FOR TYPICAL FOUNDATION DETAILS.
3. SEE DRAWING SERIES S400 FOR TYPICAL CONCRETE DETAILS.
4. SEE DRAWING SERIES S500 FOR TYPICAL STEEL DETAILS.



FOUNDATION AND BASEMENT PLAN

SCALE: 1/8"=1'-0"

PLAN NOTES:

1. TOP OF SLAB EL VARIES, SEE PLAN
2. BASEMENT SLAB AT LOADING DOCK AREA AND RAMPS:
   10" CONCRETE SLAB ON GRADE, f'c=4000 PSI, REINFORCED WITH #4@12" TOP & BOTTOM EACH WAY
   SLAB TOP BARS TO BE EPOXY COATED
   SUBGRADE PREPARATION REQUIRED PER GEOTECHNICAL RECOMMENDATIONS
   REMOVE AND REPLACE UNSUITABLE EXISTING SOIL BELOW BASEMENT SLAB PER GEOTECHNICAL RECOMMENDATIONS
3. BASEMENT SLAB AT EL -15'-0":
   6" CONCRETE SLAB ON GRADE, f'c=4000 PSI, REINFORCED WITH WWF 6x6-W2.9xW2.9
   SUBGRADE PREPARATION REQUIRED PER GEOTECHNICAL RECOMMENDATIONS
   REMOVE AND REPLACE UNSUITABLE EXISTING SOIL BELOW BASEMENT SLAB PER GEOTECHNICAL RECOMMENDATIONS
4. Px INDICATES CONCRETE PIER OR PILASTER
   SEE LEGEND ON THIS SHEET
5. ELEVATOR SUMP PIT: 1'-6"x1'-6"x1'-6"
   VERIFY SIZE AND LOCATION WITH ELEVATOR REQUIREMENTS
6. HSS6x4 POST IS PROVIDED FOR SUPPORT OF ELEVATOR GUIDE RAILS. EXACT NUMBER AND LOCATION OF POSTS TO BE DETERMINED BASED ON ELEVATOR REQUIREMENTS. CONTRACTOR TO COORDINATE WITH ELEVATOR MANUFACTURER. SEE DETAIL
7. GBx INDICATES CONCRETE GRADE BEAM
   SEE DWG S302 FOR TYPICAL DETAILS AND SCHEDULE
8. ALL DIMENSIONS AND ELEVATIONS AT DOCK LEVELER PITS MUST BE VERIFIED WITH MANUFACTURER AND WITH THE ARCH DWGS. CONTRACTOR TO COORDINATE. SEE ARCH DWGS FOR ADD'L INFORMATION.

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1	10 DEC 04	SCHEMATIC DESIGN

SHEET TITLE:

FOUNDATION AND BASEMENT PLAN

PROJECT ELEVATION + 0.0' = GRAND RAPIDS + 615.0'

SEAL:

SCALE: AS SHOWN
DRAWN BY:
CHECKED BY:
PROJECT NO.: CC4467.00

DRAWING NUMBER:

S201

SHEARWALL REINFORCEMENT SCHEDULE

CONCRETE STRENGTH f'c (PSI)	SHEARWALL MARK	SW1				SW2				SW3		SW4	
	SHEARWALL ZONE	1A & 1B		1C		2A & 2B		2C		–		–	
	FLOOR / ELEVATION	VERT EF	HORIZ EF	VERT EF	HORIZ EF	VERT EF	HORIZ EF	VERT EF	HORIZ EF	VERT EF	HORIZ EF	VERT EF	HORIZ EF
	ROOF +												
	MECH/PH +	12-#7	–	#5@12"	#4@12"	12-#7	–	#5@12"	#4@12"	#5@12"	#4@12"	#6@12"	#4@12"
	23RD +	12-#7	–			12-#7	–						
	22ND +	42-#8	–			42-#8							
	21ST +												
	20TH +											SEE 2/402	SEE 2/402
6000	19TH +												
	18TH +												
	17TH +												
	16TH +												
	15TH +												
	14TH +											#6@12"	#4@12"
	13TH +											#7@12"	#5@12"
	12TH +												
	11TH +												
8000	10TH +				#4@12"				#4@12"				
	9TH +				#5@12"				#5@12"				
	8TH +												
	7TH +	42-#8		#5@12"	#5@12"	42-#8		#5@12"	#5@12"				
	6TH +	42-#10		#9@9"	#7@6"	42-#10		#9@9"	#7@6"			SEE 2/402	SEE 2/402
	5TH +												
	4TH +												
10000	3RD +	42-#10				42-#10							
	2ND MEZZ +	42-#11				42-#11							
	2ND +												
	GROUND +												
	BASEMENT + SEE PLAN	42-#11	–	#9@9"	#7@6"	42-#11	–	#9@9"	#7@6"	#5@12"	#4@12"	#7@12"	#5@12"
	DOWELS BARS												
	DOWELS EMBEDMENT												
	REMARKS												

NOTES:
1. PROVIDE TENSION LAP SPLICES AT ALL VERTICAL BARS.
2. USE #4 @ 12 OC TIES UNLESS NOTED OTHERWISE.
3. DOWELS TO MATCH SHEARWALL VERTICAL REINFORCEMENT, UON 6

SHEARWALL REINFORCEMENT - VERTICAL BARS LAP SPLICE LENGTH SCHEDULE (INCHES)

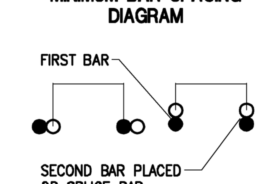
BAR SIZE	MIN. BAR SPACING (INCHES)	TENSION		
		f'c = 6 KSI	f'c = 8 KSI	f'c = 10 KSI
#4	2.000	21	18	16
#5	2.125	26	22	20
#6	2.250	31	27	24
#7	2.375	45	39	35
#8	2.500	51	44	39
#9	2.875	57	50	44
#10	3.250	64	56	50
#11	3.625	71	62	55

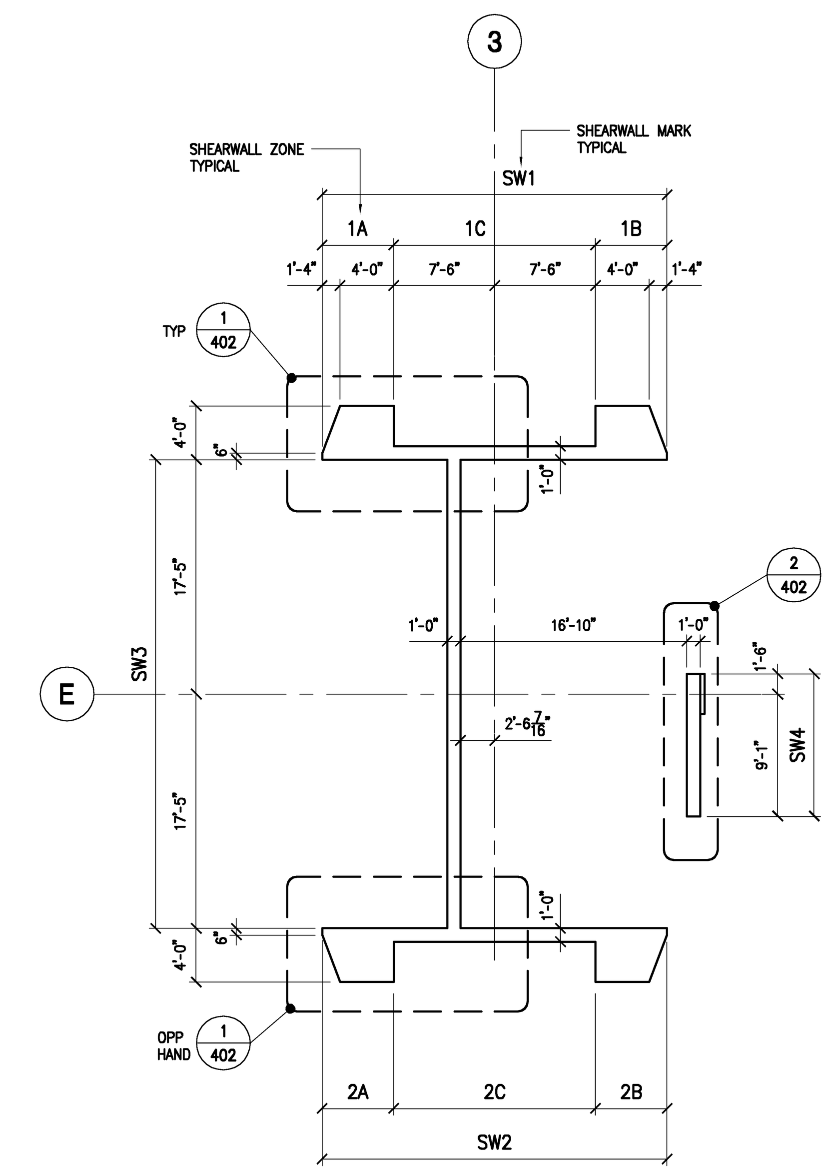
SHEARWALL REINFORCEMENT - HORIZONTAL BARS LAP SPLICE LENGTH SCHEDULE (INCHES)

BAR SIZE	MIN. BAR SPACING (INCHES)	TENSION		
		f'c = 6 KSI	f'c = 8 KSI	f'c = 10 KSI
#4	2.000	27	23	21
#5	2.125	33	29	26
#6	2.250	40	35	31
#7	2.375	58	50	45

NOTES:
1. CLEAR COVER – SEE SHEARWALL TYPICAL DETAIL.
2. WHERE BARS OF DIFFERENT SIZES ARE LAP SPLICED IN TENSION, THE LAP LENGTH SHALL BE THE LAP SPLICE LENGTH OF THE SMALLER BAR.
3. TABULATED VALUES ARE FOR NON-EPOXY-COATED REINFORCEMENT. FOR EPOXY-COATED REINFORCEMENT, MULTIPLY VALUES BY 1.5.
4. WHERE ACTUAL CONDITIONS DIFFER FROM THE PROVIDED SCHEDULE AND/OR NOTES, LENGTHS SHALL BE ADJUSTED ONLY WITH THE APPROVAL OF THE STRUCTURAL ENGINEER.

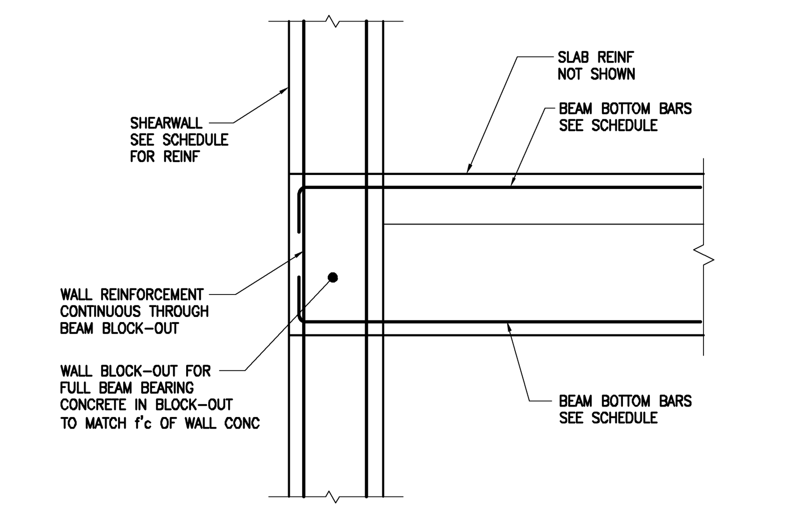
MINIMUM BAR SPACING DIAGRAM



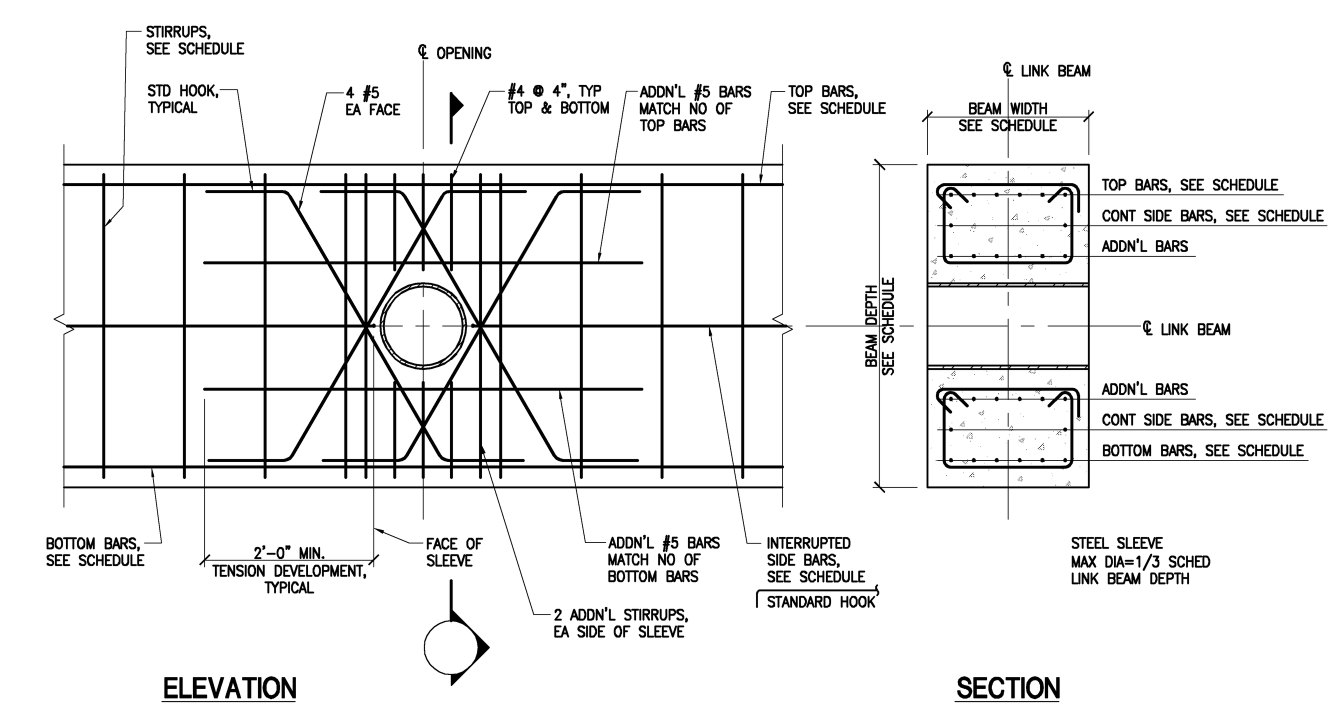


5 SHEARWALL PLAN
SCALE: 1/8"=1'-0"

1 NOTE USED
NOT TO SCALE

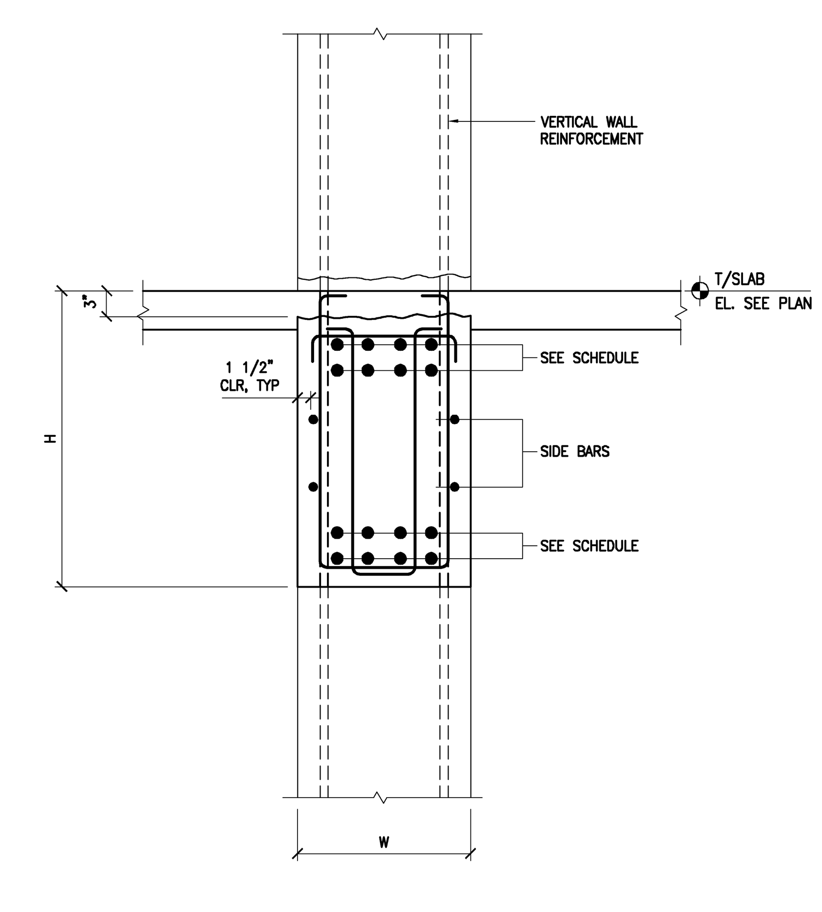


2 TYPICAL CONCRETE BEAM TO SHEARWALL CONNECTION
NOT TO SCALE



NOTES:
1. LOCATE OPENINGS AT LINK BEAM CENTERLINE ±1" UNLESS NOTED OTHERWISE ON CORE WALL ELEVATIONS
2. COORDINATE ALL PENETRATION LOCATIONS WITH MEP DRAWINGS
3. SEE MEP DRAWINGS FOR OPENINGS NOT SHOWN.
4. REINFORCEMENT CALLED OUT IN SCHEDULE IS ADDITIONAL FOR PENETRATIONS, IF ADDITIONAL REINFORCEMENT IS NOT SCHEDULED FOR PENETRATIONS, USE MINIMUM REINFORCEMENT DESCRIBED IN TYPICAL DETAILS.

3 TYPICAL LINK BEAM REINFORCING AT CIRCULAR PENETRATION
NOT TO SCALE



4 LINK BEAM SECTION AT SLIP-FORMED CORE WALL
NOT TO SCALE

JW MARRIOTT GRAND RAPIDS

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NO.	DATE	DESCRIPTION
6	09 JAN 06	ADDENDUM #6
17	02 DEC 05	ISSUED FOR CONSTRUCTION AND PERMIT
16	28 OCT 05	OWNER AND MARRIOTT CD REVIEW
15	24 OCT 05	TOWER CONCRETE BID PACKAGE
5	20 MAY 05	REVISED DESIGN DEVELOPMENT
3	29 APR 05	DESIGN DEVELOPMENT
2	15 APR 05	IN-PROGRESS DESIGN DEVELOPMENT

SHEET TITLE:

SHEARWALL SCHEDULE AND DETAILS

PROJECT ELEVATION + 0.0' = GRAND RAPIDS + 615.0'

SEAL:

SCALE: AS SHOWN
DRAWN BY:
CHECKED BY:
PROJECT NO.: CC4467.00

DRAWING NUMBER:

S401