Technical Assignment #3

Roosevelt Island Southtown Building No. 5, NY, NY

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Structural Option

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Executive Summary

Southtown Building No. 5 is a luxury apartment building located in the center of Roosevelt Island in Manhattan's East River. It houses 123 apartments in 16 floors and 130,000 square feet. The building has an underground cellar which houses storage units as well as mechanical and electrical space. The building rises 187.25 ft in the air with a 114 ft. length and an 80 ft. width. The building is the fifth out of nine apartment buildings in a development that is planning to revitalize the once industrial Roosevelt Island into a place in which people will live, work, and play. The apartment building also houses a full service lobby with concierge service and mail room, a health club, multi-purpose room, children's play area, party room, and rooftop terraces.

The goal of this technical report is to investigate the existing lateral force system used in the Southtown building. Reinforced concrete shear walls, starting from the cellar and continuing up to the top of the bulkhead, act as the primary lateral resisting system. This study will be a complete analysis of the existing system. The load and load cases have been identified, distribution of forces to individual elements has been performed, and member checks have been calculated and compared to gathered data. A combination of hand calculations and ETABS computer analysis were utilized to achieve a proper data collection.

Lateral resisting shear walls were analyzed under wind loads determined using ASCE7-05. Loads were distributed using simplified hand calculations performed using excel spreadsheets. Shear walls were more than sufficient in strength for shear and overturning moment. Deflections of walls were well within the industry standard of H/400.

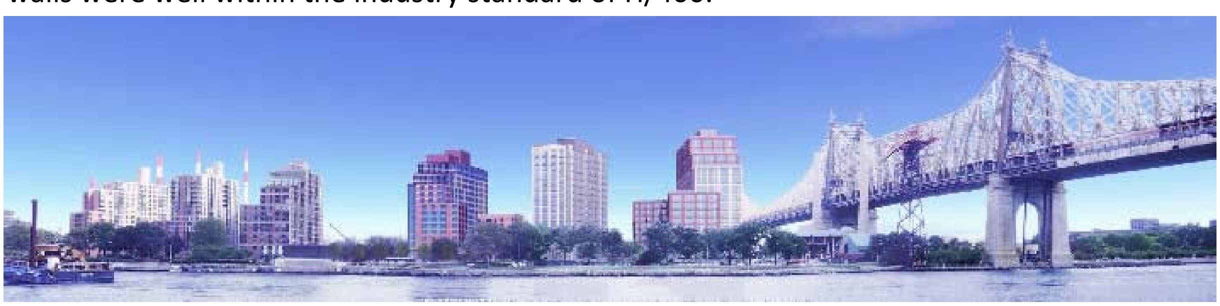


Figure 1: Panoramic View of Roosevelt Island as seen from Manhattan

EXISTING LATERAL SYSTEM

Lateral System

Reinforced concrete shear walls make up the lateral force resisting system of the building. The elevator and stairwell core in the center of the building have been assigned as the location of these shear walls. The shear walls rise from the cellar level of the building all the way to the elevator mechanical room. A 12" typical shear wall section consists of #4 @ 12" horizontal reinforcement and #5 @ 12" vertical reinforcement. Openings in the shear walls require link beams in order to transfer high shear forces from one side of the opening to the other. The concrete used in the shear walls vary with the height of the building from 7ksi in the cellar to 5ksi at the roof.

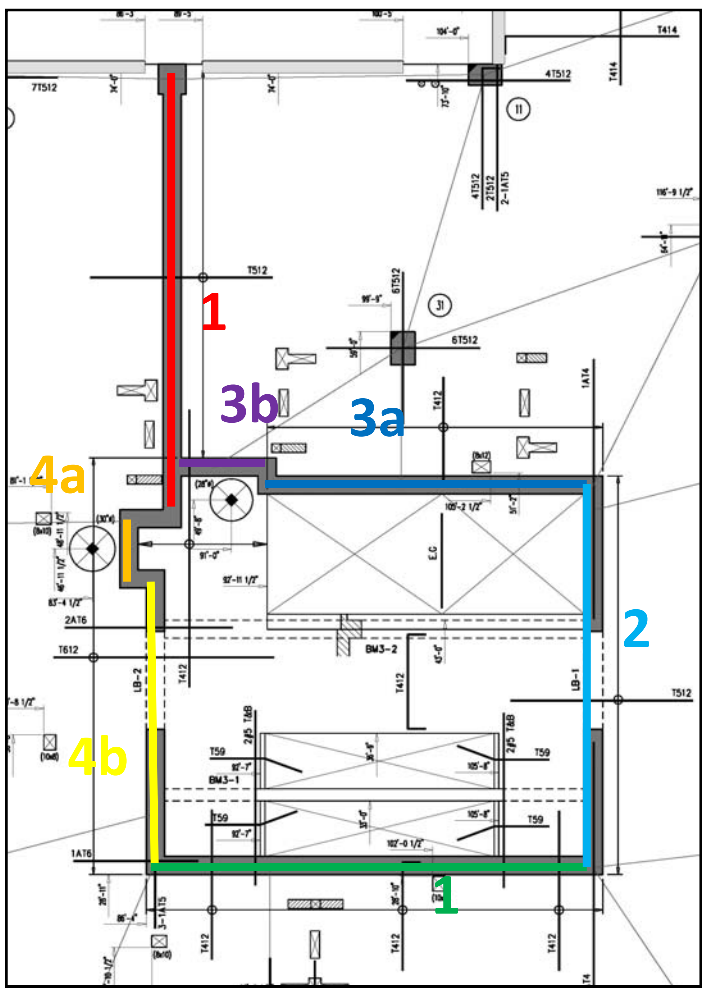


Figure 2: Shear Wall with breakdown of wall elements

CODES AND DESIGN REFERENCES

Codes and References

- Building Code
  "Building Code of the City of New York"
- Seismic Code
  "The New York City Seismic Code: Local Law 17/95"
- Structural Concrete
  "Code Requirements for Structural Concrete" (ACI 318-99), American Concrete Institute as modified by subchapter 10, article 5 of the N.Y.C Building Code
- Concrete Masonry
  "Building Code Requirements for Masonry Structures" (ACI 530-99), American Concrete Institute as modified by reference standard RS 10 -18 of the N.Y.C. Building Code

MATERIALS

Cast in Place Concrete

Foundations: 4 ksi

Foundation Walls: 5 ksi

Slabs on Ground: 4 ksi

Formed Slabs: 5 ksi

Shear Walls:

Cellar – 2nd Floor: 7 ksi

3rd Floor – 8th Floor: 6 ksi

9th Floor – EMR Roof: 5 ksi

Columns

Cellar: 4 ksi for Buttress, 7 ksi for Columns

1st Floor – 2nd Floor: 7 ksi

3rd Floor – 8th Floor: 6 ksi

9th Floor – EMR Roof: 5 ksi

Reinforcement

ASTM A615, Grade 60

Welded Wire Fabric: ASTM A185

Welded Deformed Wire Fabric: ASTM A467, Grade 60

Structural Steel

All Rolled Shapes: ASTM A572 or A992, Grade 50

All Plates and Connection Material: ASTM A36

All Tubular Sections: ASTM A500, Grade B

All Pipe Sections: A53, Grade B

Anchor Bolts: ASTM F1554

Welding Electrodes: E70XX Low Hydrogen

Bolting Materials: ASTM A325 or A490

Light Gage Framing:

16 Gage and Heavier: ASTM A653, Grade 50

18 Gage and Lighter: ASTM A653, Grade 33

LOADS

The loads for Southtown Building No. 5 are presented in an abridged form below. Story shears that act on the lateral system of the building were found for wind and seismic loading in a previous Technical Assignment. Of the two load cases studied, wind loading was found to govern in both directions. The loads presented in this section were used to determine forces present on the lateral resisting system by hand analysis and using ETABS.

Dead Loads

1. Construction Dead Load
    a. Cellar Floor: (6” slab/12)(150pcf) = 75 psf
    b. 1st Floor: (9” slab/12)(150pcf) = 113 psf
    c. 2nd -16th Floor: (8” slab/12)(150pcf) = 100 psf
    d. Main Roof: (9” slab/12)(150pcf) = 113 psf
    e. Mechanical Room Floor: (8” slab/12)(150pcf) = 100 psf
    f. E.M.R Floor: (8” slab/12)(150pcf) = 100 psf
    g. E.M.R Roof: (8” slab/12)(150pcf) = 100 psf
2. Superimposed Dead Load
    a. Cellar Floor: Columns + MEP + Misc. = 25 psf
    b. 1st Floor: Columns + MEP + Partitions + Misc. = 30 psf
    c. 2nd -16th Floor: Columns + MEP + Partitions = 20 psf
    d. Main Roof: Columns + Equip. + Misc = 50psf
    e. Mechanical Room Floor: Columns + MEP + Misc. = 25 psf
    f. E.M.R Floor: Columns + MEP + Misc. = 25 psf
    g. E.M.R Roof: Columns + MEP + Misc. = 25 psf

Live Loads

1. Cellar Floor:
    a. Equipment Rooms: 100 psf
    b. Offices: 50 psf
2. 1st Floor:
    a. Public Area: 100 psf
    b. Residential: 40psf
3. 2nd – 16th Floor: 40 psf
4. Main Roof: 100 psf – Public Area, Mechanical, Storage
5. Mechanical Room Floor: 100 psf
6. E.M.R. Floor: 100 psf – Mechanical + Machine Weight
7. E.M.R. Roof: 30 psf

- Load Combinations

1. 1.2 Dead + 1.6 Live
2. 1.2 Dead + 1.6 Live + .8 Wind
3. 1.2 Dead + 0.5 Live + 1.6 Wind
4. 0.9 Dead + 1.6 Wind

Additional Masses were added to the ETABS model to represent the effects of the floor system on the lateral resisting system. These masses were calculated using the given superimposed dead loads, construction dead loads, and the live loads. These total weights were then divided by g, 32.2 ft/sec^2. Table 1 shows the mass/ft^2 at each story.

Table 1. Mass/ft^2 per story

Floor	Weight (psf)	Mass/ft^2
EMR Roof	155	0.0048
EMR Flr	225	0.007
Mech. Rm.	225	0.007
Roof	263	0.0082
16	160	0.005
15	160	0.005
14	160	0.005
13	160	0.005
12	160	0.005
11	160	0.005
10	160	0.005
9	160	0.005
8	160	0.005
7	160	0.005
6	160	0.005
5	160	0.005
4	160	0.005
3	160	0.005
2	160	0.005
1	243	0.0075

Major Assumptions

- Southtown Building No. 5 Soil Conditions are that of Site Class C
- Normalization of the building's staggering shape into a 144' x 80' rectangle for wind analysis done by hand
- No openings in the slab are accounted for in ETABS
- Deflection analysis may be completed in ETABS
- Foundation deformation is neglected

Wind Analysis

Wind Loads

The wind load for this building is calculated based on Method 2 of ASCE 7-05 Chapter 6. For ease of analysis, the building was modeled as a 144 ft. x 80 ft. rectangular box. Through an analysis of the building's fundamental period set forth in ASCE 7-05, the building was found to behave as a flexible structure and was analyzed as such. The wind distribution is mostly linear down the face of the building with some variance due to different floor-to-ceiling height located on the first three floors.

General information and story shears may be found in Tables 2 and 3. A more detailed analysis can found in Appendix A.

Table 2. General Information	
Exposure Class	C
Importance Factor I	0.87
Topographic Factor K_{zt}	1
Wind Directionality Factor K_d	0.85
Basic Wind Speed V (mph)	110
N-S Length of Building	144
E-W Length of Building	80
No. of Stories	16
Typical Story Height (ft.)	9.33
Building Height (ft.)	187.25
L/B in N-S Direction	1.8
L/B in E-W Direction	0.56
h/L in N-S Direction	1.3
h/L in E-W Direction	2.34

Table 3. Story Shears (k)		
Level	**Shear (k)**	
	N-S	E-W
EMR Roof	8	6
EMR	25	18
Mech. Rm.	55	29
Roof	110	53
16	177	87
15	235	116
14	288	143
13	341	169
12	393	195
11	444	221
10	495	246
9	545	271
8	594	296
7	643	320
6	691	344
5	737	367
4	782	389
3	825	410
2	873	433
Total	**900**	**446**

Seismic Analysis

Seismic Loads

Seismic loads for this building were found using the appropriate sections of ASCE 7-05. The dead loads used for this section can be found in the General Notes section of the structural drawings provided for the building. These loads coincide with all applicable loads described in ASCE 7-05.

Below is a table displaying the final load, shear, and moment due to seismic loading. Story shears and total overturning moment is given in Table 4. The base shear is found to be very close to the seismic loading calculated by the structural engineers of record.

The building weight was used for the equivalent lateral force procedure is based on the column, slab, and dead loads of the building. The base shear was found to be approximately 390 kips with an overturning moment of 50,400 ft-kips.

However, the seismic loading does not control in any direction of the building. Since the wind shears are more than double the magnitude than that of the seismic shears, the wind loadings are the only story shears represented in the ETABS model.

Table 4. Seismic Story Shears and Moment Distribution							
					Load	Shear	Moment
	w_x	h_x	$w_x(h_x)$^k	C_{vx}	F_x	V_x	M_x
Level	(kips)	(ft.)			(kips)	(kips)	(ft-kips)
EMR Roof	178	187.25	6,241,136	0.025	9.73		1,821.95
EMR Floor	258	178.25	8,197,450	0.033	12.78	9.09	2,278.03
Mech Room Floor	652	167	18,183,628	0.073	28.35	21.87	4,734.22
Main Roof	2295	156.58	56,267,195	0.225	87.72	50.22	13,735.44
16	1396	144.58	29,181,113	0.117	45.49	137.94	6,577.50
15	1396	133.58	24,909,688	0.100	38.83	183.43	5,187.53
14	1396	124.25	21,551,535	0.086	33.60	222.27	4,174.70
13	1396	114.91	18,433,214	0.074	28.74	255.87	3,302.25
12	1396	105.58	15,561,402	0.062	24.26	284.61	2,561.42
11	1396	96.25	12,932,631	0.052	20.16	308.87	1,940.61
10	1396	86.92	10,546,901	0.042	16.44	329.03	1,429.21
9	1396	77.58	8,402,044	0.034	13.10	345.47	1,016.22
8	1396	68.25	6,502,655	0.026	10.14	358.57	691.90
7	1396	58.92	4,846,307	0.019	7.56	368.71	445.17
6	1396	49.58	3,431,614	0.014	5.35	376.26	265.25
5	1396	40.25	2,261,607	0.009	3.53	381.61	141.92
4	1396	30.92	1,334,641	0.005	2.08	385.14	64.34
3	1396	21.58	650,112	0.003	1.01	387.22	21.87
2	1396	12.25	209,487	0.001	0.33	388.23	4.00
Totals	24323		249,644,363	1.000	389.20	389.20	50,393.54

Shear Wall Rigidity

Shear wall rigidities were calculated using the relative rigidities of each shear wall. Relative rigidities were found using 1/Δ. A point load of 1 kip was the assumed case loading used at the top of the shear walls. Deflections due to flexure and shear were used in the analysis. The equation used to calculate the deflection of each wall was: $\Delta = Vh^3/3E_m + 1.2Vh/E_vA$. The shear wall relative rigidities can be seen in Table 5. A more detailed look at the Center of Rigidity can be seen in Appendix A.

Table 5. Relative Rigidities

Shear Wall	Relative Rigidity	
	Rx	Ry
SW1	25.15	-
SW2	-	19.41
SW3a	11.58	-
SW3b	0.26	-
SW4	-	27.42
SW5a	-	0.07
SW5b	-	7.27

Center of rigidity location was found using relative rigidities of each wall and using a zero reference point near the South-West corner of the building. The 0, 0 coordinate is circled in red. The center of rigidity calculations yielded a location of x = 75.41' in the E-W direction and y = 36.17' in the N-S direction. The center of rigidity can be seen as the blue cross in Figure 3 below.

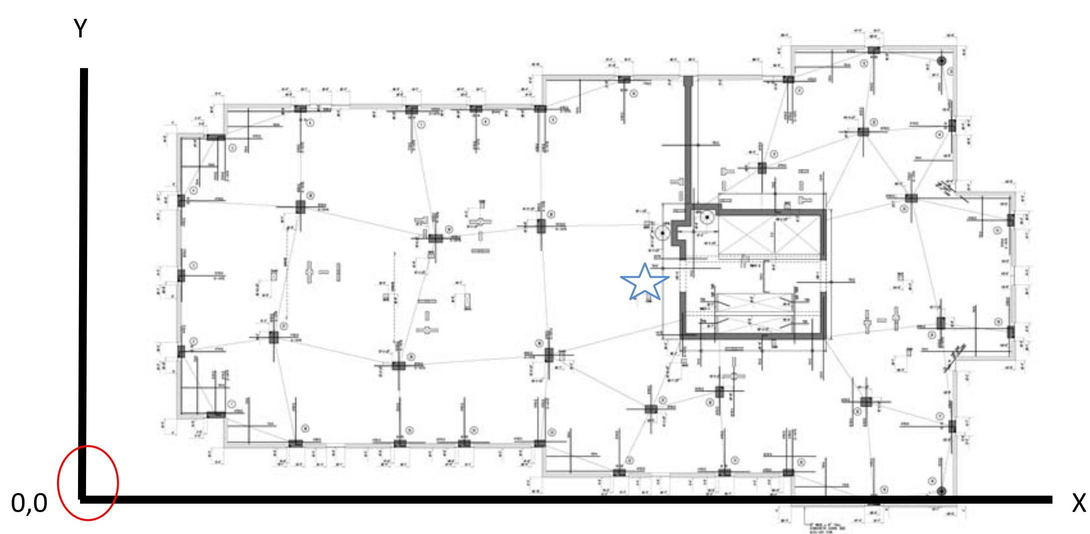


Figure 3. Center of rigidity and origin of reference

Center of Mass

The center of mass of the building is the location at which the seismic resultant forces act. Calculations to determine the center of mass were done using the same 0, 0 coordinate when calculating the center of rigidity. Masses used in determining the center of mass were the floor system and shear walls. The floor areas were broken down into 5 separate areas. They are outlined in the figure below. The center of rigidity was found to be 77.32’ in the x-direction and 40.35’ in the y direction. This point is noted below as the red star. The unit weight for floor areas only attributes for the self weight of an 8" reinforced concrete slab (8"/12)(.150kcf) = .1 ksf

Table 6. Center or Mass		
Element	Wx (ft-kips)	Wy (ft-kips)
SW1	3320.17	988.159
SW2	3413.88	1221.4
SW3a	2638.79	1307.48
SW3b	658.778	375.507
SW4	3034.54	2088.73
SW5a	397.899	218.849
SW5b	1919.21	832.551
Floor Area (A)	157.856	1565.34
Floor Area (B)	11398	12827.2
Floor Area (C)	24677.1	11688.9
Floor Area (D)	27491.8	9126.36
Floor Area (E)	4076.87	1163.52
TOTAL	83185	43404
xmass	77.3233	ft
ymass	40.3455	ft

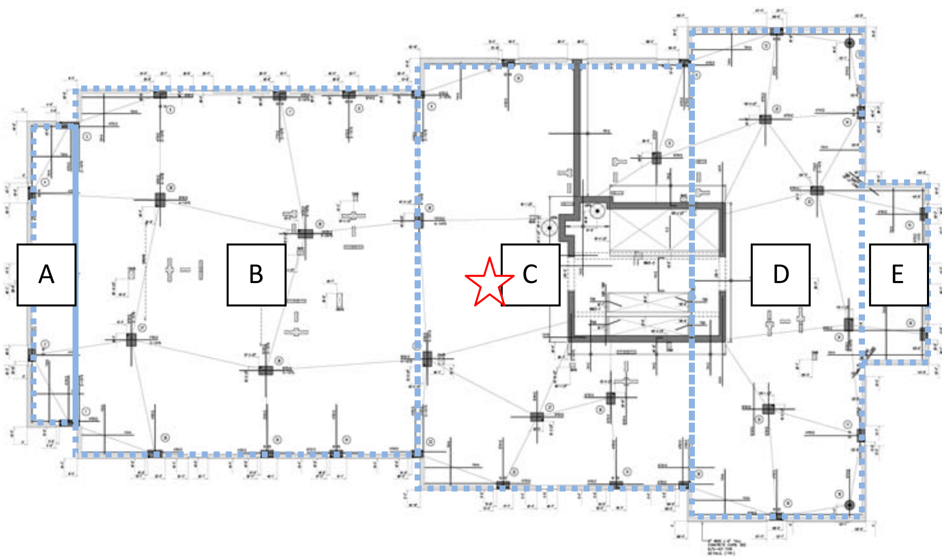


Figure 4. Center of mass and breakdown of building areas

Distribution of Shear Forces

Direct Shear

Distribution of direct shear forces were analyzed by taking the ratio of the relative rigidity of each wall to the sum of the relative rigidities of all shear walls. The direct shear force was calculated by the equation: $F_i = [V(R_i)]/ \sum R_i$. Where V is the base shear on the wall and R_i is the relative rigidity of that wall.

Shear Due to Torsion

The eccentricities created from the wind and seismic forces coupled with the center of rigidity result in torsion on the building. Torsion from seismic forces is caused by the eccentricity of the center of rigidity and the center of mass. Torsion from wind forces is caused by the center of rigidity and the geometric center of the building. The resultant shear forces from torsion can be equated into shear forces acting on the walls using the equation: $F_i = [(VeR_iC_{sw})/(\sum RC_{sw}^2)]$.

Where V is the base shear acting on the building in that direction, Ri is the relative rigidity of the wall, Csw is the orthogonal distance from the shear wall to the center of rigidity. The results of direct shear and shear due to torsion on each wall at the base of the building can be seen below in Table 7 below.

Table 7. Shear Due to Wind Forces

Shear Wall	Csw	E-W Direction		N-S Direction	
		Direct Shear (k)	Torsion Shear (k)	Direct Shear (k)	Torsion Shear (k)
SW1	6.75	0.00	55.15	94.71	16.41
SW2	35.47	43.17	6.95	0.00	2.49
SW3a	14.33	0.00	18.21	29.64	9.02
SW3b	15.33	0.00	6.66	0.29	3.80
SW4	12.34	30.98	45.81	0.00	31.54
SW5a	9.97	0.44	7.13	0.00	3.92
SW5b	11.22	6.06	34.55	0.00	14.99

- Larger shears due to torsion in the E-W Direction can be attributed to the eccentricity of the center of mass to the center of rigidity for seismic and an eccentricity between the center of mass and the geometric center of the building for wind.

Building Drift

The building drift was taken as the deflection of the shear walls at the top of the walls for each direction. These deflections were compared to a standard drift limitation of H/400. The deflections in each direction from wind shear forces can be seen below in Table 8.

Table 8. Story Displacements and Drifts							
Level	Load Combination	Building Height (ft)	Allowable Displ	E-W Direction		N-S Direction	
			H/400 (in)	ΔX (in)	Drift X (in)	ΔY (in)	Drift Y (in)
EMR ROOF	4	187	5.61	1.5815	0.000547	2.033	0.000185
EMR	4	178	5.34	1.4851	0.00052	1.9425	0.000186
MECH	4	167	5.01	1.3711	0.000561	3.3642	0.000189
MAIN ROOF	4	157	4.71	1.2656	0.000979	3.1969	0.000219
16	4	145	4.35	1.1445	0.001138	2.9929	0.000233
15	4	134	4.02	1.0335	0.001262	2.7852	0.000244
14	4	124	3.72	0.9395	0.001388	2.5976	0.000252
13	4	115	3.45	0.8461	0.0015	2.3991	0.000258
12	4	106	3.18	0.7539	0.001605	2.1913	0.000263
11	4	96	2.88	0.6632	0.001692	1.9753	0.000266
10	4	87	2.61	0.5748	0.001758	1.7532	0.000267
9	4	78	2.34	0.4894	0.00178	1.5276	0.000264
8	4	68	2.04	0.4078	0.001796	1.3027	0.00026
7	4	59	1.77	0.3305	0.001781	1.0798	0.000252
6	4	50	1.5	0.2583	0.001731	0.8624	0.000241
5	4	40	1.2	0.1922	0.001633	0.6544	0.000226
4	4	31	0.93	0.133	0.001483	0.4609	0.000196
3	4	22	0.66	0.0821	0.001263	0.2875	0.000158
2	4	12	0.36	0.0407	0.00111	0.1429	0.000186
1	4	0	0	0	0	0	0

Member Checks

Member checks for shear capacity of shear walls as well as compressive strength of walls were calculated for overturning moment and shear capacity. A nominal shear strength capacity was calculated to find adequate strength against base shear forces. Shear wall #4 which spans N-S, and shear wall #1 which spans E-W were checked. Applicable load combinations were applied to shear forces. Tributary areas were accounted for each shear wall to accommodate for axial dead loads. PCA Column was used to determine if the shear walls were adequately reinforced. The PCA Column reports can be seen in Appendix B . Also, Table 9 indicates the dead, live, and wind loads, and the applied moment imported into PCA Column for each shear wall.

Overturning of the lateral system at the base will not control the design of the foundations by inspection. Since the foundation system of the lateral system is a 4’-0” thick mat foundation, the shear mass of the system will resolve any uplift forces.

Table 9. Member Check input for PCA Column

Level	Shear Wall	Length (ft)	Thickness (ft)	N-S Direction				E-W Direction			
				Dead	Live	Wind	Moment	Dead	Live	Wind	Moment
				k	k	k	ft-k	k	k	k	ft-k
Main Roof	SW1	25	1	172.4	35.2	176.8	2143	165.3	35.2	9.73	326
1	SW1	25	1	1507.6	35.2	1231.8	2506.5	1508	35.2	185.93	5164
Main Roof	SW4	25.167	1' + 1.5' B.E.	170.1	35.2	4.45	2496	170.1	35.2	14.43	111.83
1	SW4	25.167	1' + 1.5' B.E.	1493.6	35.2	1769.8	2924.6	1494	35.2	446.24	1763.17

ETABS Model

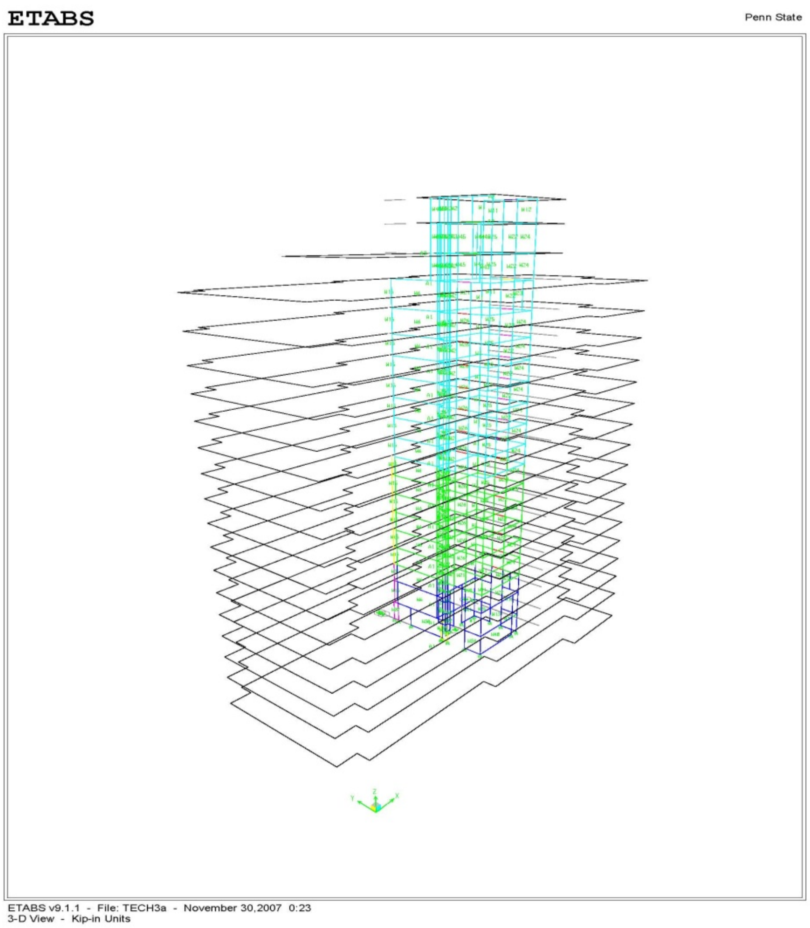


Figure 5. ETABS 3-D Model

When using ETABS the model was simplified for Southtown Building No. 5 to the lateral system consisting of the reinforced concrete shear walls and the slab edge which acted as a diaphragm at each level. The analysis technique permits a more direct analysis and interpolation of the results and easier application of the loads. The wind loads were applied at each floor manually using the story forces calculated in the previous sections.

When comparing the animated results and story displacement values, it is clear that there is some wind-related torsion created. The expected levels of shear in the frames and shear walls as previously assumed were confirmed. Additionally, the forces were hand calculated and cross checked with the base shears of ETABS to confirm that the model was correctly developed and run.

Conclusion

The lateral system loads acting on the building were controlled by wind in both directions. The wind loading in the N-S direction resulted in a 900 kip base shear and the E-W direction resulted in a 446 base shear whereas the seismic loading resulted in a 389 kip base shear. Seismic forces did not govern and were not accounted for in the ETABS model. From the ETABS model and the PCA Column member checks, the shear walls were adequate to resist the applied loads. Lateral forces were distributed to shear walls by relative rigidities of each wall. The total deflections resulting from the wind loading were all well under the generally accepted industry standard of H/400 and most were in the H/800 to H/1000 range.

Spot check calculations yielded shear strength capacity in excess of necessary strength. The width of the shear walls might have been increased to 12” for ease of rebar placement, as well as maintaining a consistent width of entire wall for ease of forms and labor.

Appendix

Appendix A

Table 10. Flexible Building Gust Factor Calculations						
gR =	3.9787		E-W direction			N-S direction
mean Vz =	126.6172		L =	144 ft.	L =	80 ft.
N1 =	2.1308		B =	80 ft.	B =	144 ft.
Rn =	0.0859		hh =	2.8730	hh =	2.8730
			Rh =	0.2877	Rh =	0.2877
			hB =	1.2275	hB =	2.2094
			RB =	0.5113	RB =	0.3514
			hL =	7.3967	hL =	4.1093
			RL =	0.1261	RL =	0.2137
			R =	0.7045	R =	0.6041
			Gf =	1.0097	Gf =	0.9690

Table 11. Wind Calculations

Level	hx (ft)	E-W DIRECTION WIND					N-S DIRECTION WIND				
		Leeward Cp	Total pressure (psf)	Story Force (k)	Shear (k)	Moment (ft-k)	Leeward Cp	Total pressure (psf)	Story Force (k)	Shear (k)	Moment (ft-k)
EMR Roof	187	-0.43	40.99	5.53	6	1123.50	-0.50	41.68	7.69	8	1498.00
EMR Roof	178	-0.43	40.71	12.37	18	3208.50	-0.50	41.41	17.19	25	4456.25
Mech Rm	167	-0.24	34.17	11.11	29	4843.00	-0.50	41.07	29.80	55	9185.00
Main Roof	157	-0.34	37.10	23.61	53	8298.74	-0.50	40.73	55.35	110	17223.80
16	145	-0.34	36.68	33.74	87	12578.46	-0.50	40.32	66.76	177	25590.66
15	134	-0.34	36.26	29.49	116	15495.28	-0.50	39.92	58.43	235	31391.30
14	124	-0.34	35.88	26.78	143	17767.75	-0.50	39.55	53.14	288	35784.00
13	115	-0.34	35.48	26.50	169	19421.48	-0.50	39.17	52.66	341	39187.72
12	106	-0.34	35.06	26.18	195	20588.10	-0.50	38.76	52.10	393	41492.94
11	96	-0.34	34.60	25.82	221	21271.25	-0.50	38.32	51.49	444	42735.00
10	87	-0.34	34.10	25.47	246	21382.32	-0.50	37.85	50.88	495	43025.40
9	78	-0.34	33.57	25.07	271	21024.18	-0.50	37.33	50.19	545	42281.10
8	68	-0.34	32.98	24.61	296	20202.00	-0.50	36.77	49.40	594	40540.50
7	59	-0.34	32.32	24.13	320	18854.40	-0.50	36.13	48.57	643	37885.56
6	50	-0.34	31.57	23.58	344	17055.52	-0.50	35.42	47.61	691	34259.78
5	40	-0.34	30.70	22.92	367	14771.75	-0.50	34.58	46.47	737	29664.25
4	31	-0.34	29.66	22.15	389	12027.88	-0.50	33.58	45.14	782	24179.44
3	22	-0.34	28.32	21.15	410	8847.80	-0.50	32.30	43.42	825	17803.50
2	12	-0.34	27.07	23.37	433	5304.25	-0.50	31.10	48.33	873	10694.25
1	0	-0.34	27.07	13.27	446.00	0.00	-0.50	31.10	27.43	**900**	0.00

[redacted]

Table . Center of Rigidity						
Shear Wall	Distance from Zero Reference		Relative Rigidity		(Rx)y	(Ry)x
	E-W (x) (ft)	N-S (y) (ft)	Rx	Ry		
SW1	98.85	**29.42**	25.15	-	739.90	-
SW2	**110.88**	39.67	-	19.41	-	2152.11
SW3a	101.92	**50.5**	11.58	-	584.59	-
SW3b	90.35	**51.5**	0.26	-	13.39	-
SW4	**87.75**	60.4	-	27.42	-	1656.34
SW5a	**85.38**	46.96	-	0.07	-	3.20
SW5b	**86.63**	37.58	-	7.27	-	273.25
Total			36.99	54.17	1337.89	4084.90
Yr =	36.17	ft				
Xr =	75.41	ft				

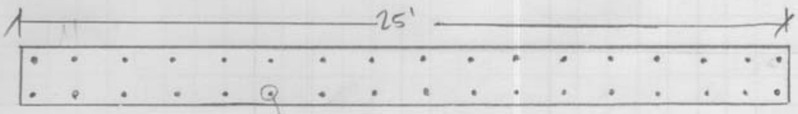
Table 6. Center of Mass								
Element	Wall Length (ft)	Wall Height per floor (ft)	Unit Weight (k/sf)	Weight (kips)	Distance from zero reference		Wx (ft-kips)	Wy (ft-kips)
					x (ft)	y (ft)		
SW1	24	9.33	0.15	33.59	98.85	29.42	3320.17	988.16
SW2	22	9.33	0.15	30.79	110.88	39.67	3413.88	1221.40
SW3a	18.5	9.33	0.15	25.89	101.92	50.50	2638.79	1307.48
SW3b	5.21	9.33	0.15	7.29	90.35	51.50	658.78	375.51
SW4	24.71	9.33	0.15	34.58	87.75	60.40	3034.54	2088.73
SW5a	3.33	9.33	0.15	4.66	85.38	46.96	397.90	218.85
SW5b	15.83	9.33	0.15	22.15	86.63	37.58	1919.21	832.55
	Fl Area Length (ft)	Fl Area Width (ft)						
Floor Area (A)	49.33	8.00	0.10	39.46	4.00	39.67	157.86	1565.34
Floor Area (B)	59.33	54.50	0.10	323.35	35.25	39.67	11398.03	12827.23
Floor Area (C)	69.33	42.50	0.10	294.65	83.75	39.67	24677.15	11688.86
Floor Area (D)	79.33	29.00	0.10	230.06	119.50	39.67	27491.81	9126.36
Floor Area (E)	29.33	10.00	0.10	29.33	139.00	39.67	4076.87	1163.52
TOTAL				1075.81			83184.99	43404.00

xmass	77.32	ft
ymass	40.35	ft

Appendix B

MEMBER CHECKS

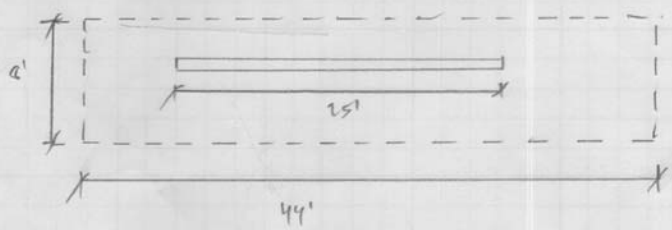
SW 1



#6 @ 12" @ BASE
#5 @ 12" @ ROOF

$f'_c = 7000$ psi

TRIB AREA.



DEAD
352 ft² (143 psf DEAD)(16) = 805.4 k AT BASE
352 ft² (163 psf) = 57.4 k @ Main Roof

LIVE
352 ft² (100 psf) = 35.2 k @ base & MAIN ROOF

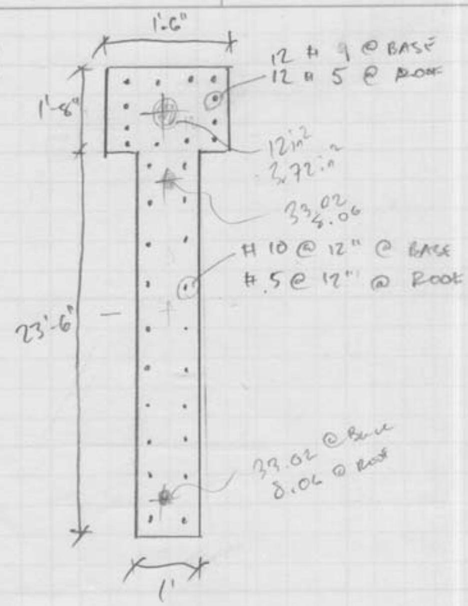
S.W.
(1')(25') = 25 ft² (187.25') = 4681.25 ft³ (.150 kcf) = 702.2 k @ base.
(1')(25') = 25 ft² (30.67') = 766.75 ft³ (.150 kcf) = 115 k @ Main Roof.

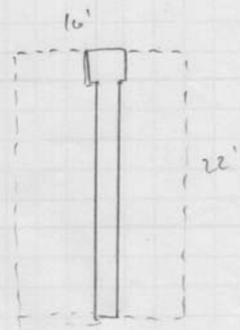
INPUT INTO PCA COLUMN.

- OK ; SEE RESULTS.

MEMBER CHECK

SW4





DEAD

352 ft² (143 psf) (16 floors) = 805.4 k @ BASE

352 ft² (163 psf) = 57.4 k @ ROOF

LIVE

352 ft² (100 psf) = 35.2 k @ BASE & ROOF

S.W.

[(22')(1') + (1.667)'(1.5)'] (187.25') (.15 kcf) = 688.16 k @ BASE

[(22')(1') + (1.667)'(1.5)'] (30.67') (.15 kcf) = 112.7 k @ ROOF

INPUT INTO PCA COLUMN.

SEE RESULTS.

Shear Wall 1 @ Base

```
General Information:
====================
   File Name: untitled.col
   Project:  Shear Wall 1 @ Base
   Column:   SW1                               Engineer: SRS
   Code:     ACI 318-02                        Units: English

   Run Option: Investigation                   Slenderness: Not considered
   Run Axis:   Biaxial                         Column Type: Architectural

Material Properties:
====================
   f'c   = 7 ksi                               fy   = 60 ksi
   Ec    = 4768.97 ksi                         Es   = 29000 ksi
   Ultimate strain = 0.003 in/in
   Beta1 = 0.7

Section:
========
   Rectangular: Width = 300.5 in               Depth = 12 in

   Gross section area, Ag =  3606 in^2
   Ix =  43272 in^4                            Iy =  2.71352e+007 in^4
   Xo =  0 in                                  Yo =  0 in

Reinforcement:
==============
   Rebar Database: ASTM A615
   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
   ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
   #  3    0.38        0.11     #  4    0.50        0.20     #  5    0.63        0.31
   #  6    0.75        0.44     #  7    0.88        0.60     #  8    1.00        0.79
   #  9    1.13        1.00     # 10    1.27        1.27     # 11    1.41        1.56
   # 14    1.69        2.25     # 18    2.26        4.00

   Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
   phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

   Layout: Rectangular
   Pattern: All Sides Equal  (Cover to transverse reinforcement)
   Total steel area, As = 24.64 in^2 at 0.68%
   56 #6   Cover = 1.5 in

Load Combinations:
==================
   U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake
   U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake
   U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake
   U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake
   U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake
   U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake
   U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake
   U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake
   U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake
   U10 =  1.200*Dead + 1.000*Live + 0.000*Wind + 1.000*EarthQuake
   U11 =  0.900*Dead + 0.000*Live + 0.000*Wind + 1.000*EarthQuake
   U12 =  1.200*Dead + 1.000*Live + 0.000*Wind - 1.000*EarthQuake
   U13 =  0.900*Dead + 0.000*Live + 0.000*Wind - 1.000*EarthQuake
```

Service Loads:

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	1507.6	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	1231.8	0.0	0.0	2506.0	2506.0
	E.Q.	0.0	0.0	0.0	0.0	0.0
2	Dead	1507.6	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	185.9	0.0	0.0	5164.0	5164.0
	E.Q.	0.0	0.0	0.0	0.0	0.0

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	fMnx k-ft	fMny k-ft	fMn/Mu
1	1 U1	2110.6	0.0	0.0	1280.0	0.0	999.999
2		2110.6	0.0	0.0	1280.0	0.0	999.999
3	1 U2	1865.4	0.0	0.0	1211.5	0.0	999.999
4		1865.4	0.0	0.0	1211.5	0.0	999.999
5	1 U3	1844.3	0.0	0.0	1205.5	0.0	999.999
6		1844.3	0.0	0.0	1205.5	0.0	999.999
7	1 U4	2794.6	0.0	2004.8	-0.0	40568.7	20.236
8		2794.6	0.0	-2004.8	0.0	-40568.7	20.236
9	1 U5	3815.2	0.0	4009.6	-0.0	38247.5	9.539
10		3815.2	0.0	-4009.6	0.0	-38247.6	9.539
11	1 U6	3327.7	0.0	4009.6	-0.0	42380.8	10.570
12		3327.7	0.0	-4009.6	0.0	-42380.9	10.570
13	1 U7	823.7	0.0	-2004.8	0.0	-24777.2	12.359
14		823.7	0.0	2004.8	-0.0	24777.2	12.359
15	1 U8	-126.6	0.0	-4009.6	0.0	-14677.8	3.661
16		-126.6	0.0	4009.6	-0.0	14677.8	3.661
17	1 U9	-614.0	0.0	-4009.6	0.0	-8846.3	2.206
18		-614.0	0.0	4009.6	-0.0	8846.3	2.206
19	1 U10	1844.3	0.0	0.0	1205.5	0.0	999.999
20		1844.3	0.0	0.0	1205.5	0.0	999.999
21	1 U11	1356.8	0.0	0.0	1058.2	0.0	999.999
22		1356.8	0.0	0.0	1058.2	0.0	999.999
23	1 U12	1844.3	0.0	0.0	1205.5	0.0	999.999
24		1844.3	0.0	0.0	1205.5	0.0	999.999
25	1 U13	1356.8	0.0	0.0	1058.2	0.0	999.999
26		1356.8	0.0	0.0	1058.2	0.0	999.999
27	2 U1	2110.6	0.0	0.0	1280.0	0.0	999.999
28		2110.6	0.0	0.0	1280.0	0.0	999.999
29	2 U2	1865.4	0.0	0.0	1211.5	0.0	999.999
30		1865.4	0.0	0.0	1211.5	0.0	999.999
31	2 U3	1844.3	0.0	0.0	1205.5	0.0	999.999
32		1844.3	0.0	0.0	1205.5	0.0	999.999
33	2 U4	1957.9	0.0	4131.2	-0.0	34732.1	8.407
34		1957.9	0.0	-4131.2	0.0	-34732.1	8.407
35	2 U5	2141.8	0.0	8262.4	-0.0	36113.8	4.371
36		2141.8	0.0	-8262.4	0.0	-36113.8	4.371
37	2 U6	1654.3	0.0	8262.4	-0.0	32288.4	3.908
38		1654.3	0.0	-8262.4	0.0	-32288.4	3.908
39	2 U7	1660.4	0.0	-4131.2	0.0	-32338.2	7.828
40		1660.4	0.0	4131.2	-0.0	32338.2	7.828
41	2 U8	1546.8	0.0	-8262.4	0.0	-31396.8	3.800
42		1546.8	0.0	8262.4	-0.0	31396.8	3.800
43	2 U9	1059.4	0.0	-8262.4	0.0	-27041.7	3.273
44		1059.4	0.0	8262.4	-0.0	27041.7	3.273
45	2 U10	1844.3	0.0	0.0	1205.5	0.0	999.999
46		1844.3	0.0	0.0	1205.5	0.0	999.999
47	2 U11	1356.8	0.0	0.0	1058.2	0.0	999.999
48		1356.8	0.0	0.0	1058.2	0.0	999.999
49	2 U12	1844.3	0.0	0.0	1205.5	0.0	999.999
50		1844.3	0.0	0.0	1205.5	0.0	999.999
51	2 U13	1356.8	0.0	0.0	1058.2	0.0	999.999
52		1356.8	0.0	0.0	1058.2	0.0	999.999

*** Program completed as requested! ***

Shear Wall 1 @ Main Roof

```
General Information:
====================
   File Name: P:\Thesis\SW1 @ base.col
   Project:  Shear Wall 1 @ Main Roof
   Column:   SW1                              Engineer: SRS
   Code:     ACI 318-02                       Units: English

   Run Option: Investigation                  Slenderness: Not considered
   Run Axis:   Biaxial                        Column Type: Architectural

Material Properties:
====================
   f'c   = 5 ksi                              fy   = 60 ksi
   Ec    = 4030.51 ksi                        Es   = 29000 ksi
   Ultimate strain = 0.003 in/in
   Beta1 = 0.8

Section:
========
   Rectangular: Width = 300.5 in              Depth = 12 in

   Gross section area, Ag =  3606 in^2
   Ix =  43272 in^4                           Iy =  2.71352e+007 in^4
   Xo =  0 in                                 Yo =  0 in

Reinforcement:
==============
   Rebar Database: ASTM A615
   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
   ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
   #  3     0.38        0.11    #  4     0.50        0.20    #  5     0.63        0.31
   #  6     0.75        0.44    #  7     0.88        0.60    #  8     1.00        0.79
   #  9     1.13        1.00    # 10     1.27        1.27    # 11     1.41        1.56
   # 14     1.69        2.25    # 18     2.26        4.00

   Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
   phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

   Layout: Rectangular
   Pattern: All Sides Equal  (Cover to transverse reinforcement)
   Total steel area, As = 17.36 in^2 at 0.48%
   56 #5    Cover = 1.5 in

Load Combinations:
=================
   U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake
   U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake
   U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake
   U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake
   U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake
   U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake
   U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake
   U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake
   U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake
   U10 =  1.200*Dead + 1.000*Live + 0.000*Wind + 1.000*EarthQuake
   U11 =  0.900*Dead + 0.000*Live + 0.000*Wind + 1.000*EarthQuake
   U12 =  1.200*Dead + 1.000*Live + 0.000*Wind - 1.000*EarthQuake
   U13 =  0.900*Dead + 0.000*Live + 0.000*Wind - 1.000*EarthQuake
```

Service Loads:

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	172.4	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	176.8	0.0	0.0	2143.0	2143.0
	E.Q.	0.0	0.0	0.0	0.0	0.0
2	Dead	1507.6	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	185.9	0.0	0.0	5164.0	5164.0
	E.Q.	0.0	0.0	0.0	0.0	0.0
3	Dead	165.3	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	9.7	0.0	0.0	326.0	326.0
	E.Q.	0.0	0.0	0.0	0.0	0.0

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	fMnx k-ft	fMny k-ft	fMn/Mu
1	1 U1	241.4	0.0	0.0	477.2	0.0	999.999
2		241.4	0.0	0.0	477.2	0.0	999.999
3	1 U2	263.2	0.0	0.0	484.6	0.0	999.999
4		263.2	0.0	0.0	484.6	0.0	999.999
5	1 U3	242.1	0.0	0.0	477.5	0.0	999.999
6		242.1	0.0	0.0	477.5	0.0	999.999
7	1 U4	348.3	0.0	1714.4	-0.0	14841.4	8.657
8		348.3	0.0	-1714.4	0.0	-14841.4	8.657
9	1 U5	525.0	0.0	3428.8	-0.0	16493.9	4.810
10		525.0	0.0	-3428.8	0.0	-16493.9	4.810
11	1 U6	438.0	0.0	3428.8	-0.0	15689.4	4.576
12		438.0	0.0	-3428.8	0.0	-15689.4	4.576
13	1 U7	65.4	0.0	-1714.4	0.0	-11972.9	6.984
14		65.4	0.0	1714.4	-0.0	11972.9	6.984
15	1 U8	-40.8	0.0	-3428.8	0.0	-10817.4	3.155
16		-40.8	0.0	3428.8	-0.0	10817.4	3.155
17	1 U9	-127.7	0.0	-3428.8	0.0	-9848.8	2.872
18		-127.7	0.0	3428.8	-0.0	9848.8	2.872
19	1 U10	242.1	0.0	0.0	477.5	0.0	999.999
20		242.1	0.0	0.0	477.5	0.0	999.999
21	1 U11	155.2	0.0	0.0	447.9	0.0	999.999
22		155.2	0.0	0.0	447.9	0.0	999.999
23	1 U12	242.1	0.0	0.0	477.5	0.0	999.999
24		242.1	0.0	0.0	477.5	0.0	999.999
25	1 U13	155.2	0.0	0.0	447.9	0.0	999.999
26		155.2	0.0	0.0	447.9	0.0	999.999
27	2 U1	2110.6	0.0	0.0	708.1	0.0	999.999
28		2110.6	0.0	0.0	708.1	0.0	999.999
29	2 U2	1865.4	0.0	0.0	704.4	0.0	999.999
30		1865.4	0.0	0.0	704.4	0.0	999.999
31	2 U3	1844.3	0.0	0.0	703.9	0.0	999.999
32		1844.3	0.0	0.0	703.9	0.0	999.999
33	2 U4	1957.9	0.0	4131.2	-0.0	24373.4	5.900
34		1957.9	0.0	-4131.2	0.0	-24373.4	5.900
35	2 U5	2141.8	0.0	8262.4	-0.0	22467.9	2.719
36		2141.8	0.0	-8262.4	0.0	-22467.9	2.719
37	2 U6	1654.3	0.0	8262.4	-0.0	24554.4	2.972
38		1654.3	0.0	-8262.4	0.0	-24554.4	2.972

39	2 U7	1660.4	0.0	-4131.2	0.0	-24585.1	5.951
40		1660.4	0.0	4131.2	-0.0	24585.1	5.951
41	2 U8	1546.8	0.0	-8262.4	0.0	-23972.2	2.901
42		1546.8	0.0	8262.4	-0.0	23972.2	2.901
43	2 U9	1059.4	0.0	-8262.4	0.0	-20857.4	2.524
44		1059.4	0.0	8262.4	-0.0	20857.4	2.524
45	2 U10	1844.3	0.0	0.0	703.9	0.0	999.999
46		1844.3	0.0	0.0	703.9	0.0	999.999
47	2 U11	1356.8	0.0	0.0	765.0	0.0	999.999
48		1356.8	0.0	0.0	765.0	0.0	999.999
49	2 U12	1844.3	0.0	0.0	703.9	0.0	999.999
50		1844.3	0.0	0.0	703.9	0.0	999.999
51	2 U13	1356.8	0.0	0.0	765.0	0.0	999.999
52		1356.8	0.0	0.0	765.0	0.0	999.999
53	3 U1	231.5	0.0	0.0	473.9	0.0	999.999
54		231.5	0.0	0.0	473.9	0.0	999.999
55	3 U2	254.7	0.0	0.0	481.8	0.0	999.999
56		254.7	0.0	0.0	481.8	0.0	999.999
57	3 U3	233.6	0.0	0.0	474.6	0.0	999.999
58		233.6	0.0	0.0	474.6	0.0	999.999
59	3 U4	206.2	0.0	260.8	-0.0	13427.4	51.485
60		206.2	0.0	-260.8	0.0	-13427.4	51.485
61	3 U5	249.2	0.0	521.6	-0.0	13862.8	26.577
62		249.2	0.0	-521.6	0.0	-13862.8	26.577
63	3 U6	164.4	0.0	521.6	-0.0	12999.6	24.922
64		164.4	0.0	-521.6	0.0	-12999.6	24.922
65	3 U7	190.6	0.0	-260.8	0.0	-13268.6	50.876
66		190.6	0.0	260.8	-0.0	13268.6	50.876
67	3 U8	218.0	0.0	-521.6	0.0	-13547.9	25.974
68		218.0	0.0	521.6	-0.0	13547.9	25.974
69	3 U9	133.2	0.0	-521.6	0.0	-12678.6	24.307
70		133.2	0.0	521.6	-0.0	12678.6	24.307
71	3 U10	233.6	0.0	0.0	474.6	0.0	999.999
72		233.6	0.0	0.0	474.6	0.0	999.999
73	3 U11	148.8	0.0	0.0	445.7	0.0	999.999
74		148.8	0.0	0.0	445.7	0.0	999.999
75	3 U12	233.6	0.0	0.0	474.6	0.0	999.999
76		233.6	0.0	0.0	474.6	0.0	999.999
77	3 U13	148.8	0.0	0.0	445.7	0.0	999.999
78		148.8	0.0	0.0	445.7	0.0	999.999

*** Program completed as requested! ***

Shear Wall 4 @ Base

```
General Information:
====================
   File Name: P:\Thesis\SW4 @ base.col
   Project:  Shear Wall 4 @ Base
   Column:   SW4                           Engineer: SRS
   Code:     ACI 318-02                    Units: English

   Run Option: Investigation               Slenderness: Not considered
   Run Axis:   Biaxial                     Column Type: Architectural

Material Properties:
====================
   f'c    = 5 ksi                          fy    = 60 ksi
   Ec     = 4030.51 ksi                    Es    = 29000 ksi
   Ultimate strain = 0.003 in/in
   Beta1 = 0.8

Section:
========
   Rectangular: Width = 302 in             Depth = 12 in

   Gross section area, Ag =  3624 in^2
   Ix =  43488 in^4                        Iy =  2.75436e+007 in^4
   Xo =  0 in                              Yo =  0 in

Reinforcement:
==============
   Rebar Database: ASTM A615
   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
   ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
   #  3     0.38        0.11    #  4     0.50        0.20    #  5     0.63        0.31
   #  6     0.75        0.44    #  7     0.88        0.60    #  8     1.00        0.79
   #  9     1.13        1.00    # 10     1.27        1.27    # 11     1.41        1.56
   # 14     1.69        2.25    # 18     2.26        4.00

   Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
   phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

   Pattern: Irregular

   Total steel area, As = 81.28 in^2 at 2.24%

   Area in^2   X (in)   Y (in)   Area in^2   X (in)   Y (in)   Area in^2   X (in)   Y (in)
   --------- -------- --------   --------- -------- --------   --------- -------- --------
       15.24   -141.0      0.0       33.02   -125.0      0.0       33.02    145.0      0.0

Load Combinations:
==================
   U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake
   U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake
   U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake
   U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake
   U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake
   U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake
   U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake
   U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake
   U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake
   U10 =  1.200*Dead + 1.000*Live + 0.000*Wind + 1.000*EarthQuake
   U11 =  0.900*Dead + 0.000*Live + 0.000*Wind + 1.000*EarthQuake
   U12 =  1.200*Dead + 1.000*Live + 0.000*Wind - 1.000*EarthQuake
   U13 =  0.900*Dead + 0.000*Live + 0.000*Wind - 1.000*EarthQuake
```

Service Loads:

==============

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	1493.6	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	1769.8	0.0	0.0	2924.6	2924.6
	E.Q.	0.0	0.0	0.0	0.0	0.0
2	Dead	1493.6	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	446.2	0.0	0.0	1763.2	1763.2
	E.Q.	0.0	0.0	0.0	0.0	0.0

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

==

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	fMnx k-ft	fMny k-ft	fMn/Mu
1	1 U1	2091.0	0.0	0.0	1069.3	0.0	999.999
2		2091.0	0.0	0.0	1069.3	0.0	999.999
3	1 U2	1848.6	0.0	0.0	1050.1	0.0	999.999
4		1848.6	0.0	0.0	1050.1	0.0	999.999
5	1 U3	1827.5	0.0	0.0	1048.5	0.0	999.999
6		1827.5	0.0	0.0	1048.5	0.0	999.999
7	1 U4	3208.2	0.0	2339.7	-0.0	80834.1	34.549
8		3208.2	0.0	-2339.7	0.0	-73823.2	31.553
9	1 U5	4659.2	0.0	4679.4	-0.0	61490.2	13.141
10		4659.2	0.0	-4679.4	0.0	-83705.4	17.888
11	1 U6	4175.9	0.0	4679.4	-0.0	63815.3	13.638
12		4175.9	0.0	-4679.4	0.0	-80940.3	17.297
13	1 U7	376.5	0.0	-2339.7	0.0	-46304.8	19.791
14		376.5	0.0	2339.7	-0.0	63346.7	27.075
15	1 U8	-1004.2	0.0	-4679.4	0.0	-31564.5	6.745
16		-1004.2	0.0	4679.4	-0.0	47641.8	10.181
17	1 U9	-1487.4	0.0	-4679.4	0.0	-26386.5	5.639
18		-1487.4	0.0	4679.4	-0.0	41823.1	8.938
19	1 U10	1827.5	0.0	0.0	1048.5	0.0	999.999
20		1827.5	0.0	0.0	1048.5	0.0	999.999
21	1 U11	1344.2	0.0	0.0	1009.3	0.0	999.999
22		1344.2	0.0	0.0	1009.3	0.0	999.999
23	1 U12	1827.5	0.0	0.0	1048.5	0.0	999.999
24		1827.5	0.0	0.0	1048.5	0.0	999.999
25	1 U13	1344.2	0.0	0.0	1009.3	0.0	999.999
26		1344.2	0.0	0.0	1009.3	0.0	999.999
27	2 U1	2091.0	0.0	0.0	1069.3	0.0	999.999
28		2091.0	0.0	0.0	1069.3	0.0	999.999
29	2 U2	1848.6	0.0	0.0	1050.1	0.0	999.999
30		1848.6	0.0	0.0	1050.1	0.0	999.999
31	2 U3	1827.5	0.0	0.0	1048.5	0.0	999.999
32		1827.5	0.0	0.0	1048.5	0.0	999.999
33	2 U4	2149.3	0.0	1410.5	-0.0	78534.7	55.677
34		2149.3	0.0	-1410.5	0.0	-64277.6	45.570
35	2 U5	2541.5	0.0	2821.1	-0.0	81123.8	28.756
43	2 U9	630.3	0.0	-2821.1	0.0	-48995.7	17.368
44		630.3	0.0	2821.1	-0.0	65870.8	23.350
45	2 U10	1827.5	0.0	0.0	1048.5	0.0	999.999
46		1827.5	0.0	0.0	1048.5	0.0	999.999
47	2 U11	1344.2	0.0	0.0	1009.3	0.0	999.999
48		1344.2	0.0	0.0	1009.3	0.0	999.999
49	2 U12	1827.5	0.0	0.0	1048.5	0.0	999.999
50		1827.5	0.0	0.0	1048.5	0.0	999.999
51	2 U13	1344.2	0.0	0.0	1009.3	0.0	999.999
52		1344.2	0.0	0.0	1009.3	0.0	999.999

*** Program completed as requested! ***

Shear Wall 4 @ Main Roof

```
General Information:
====================
   File Name: P:\Thesis\SW4 @ roof.col
   Project:  Shear Wall 4 @ Roof
   Column:   SW4                             Engineer: SRS
   Code:     ACI 318-02                      Units: English

   Run Option: Investigation                 Slenderness: Not considered
   Run Axis:   Biaxial                       Column Type: Architectural

Material Properties:
====================
   f'c   = 5 ksi                             fy   = 60 ksi
   Ec    = 4030.51 ksi                       Es   = 29000 ksi
   Ultimate strain = 0.003 in/in
   Beta1 = 0.8

Section:
========
   Rectangular: Width = 302 in               Depth = 12 in

   Gross section area, Ag =  3624 in^2
   Ix =  43488 in^4                          Iy =  2.75436e+007 in^4
   Xo =  0 in                                Yo =  0 in

Reinforcement:
==============
   Rebar Database: ASTM A615
   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)   Size Diam (in) Area (in^2)
   ---- --------- -----------   ---- --------- -----------   ---- --------- -----------
   #  3      0.38        0.11   #  4      0.50        0.20   #  5      0.63        0.31
   #  6      0.75        0.44   #  7      0.88        0.60   #  8      1.00        0.79
   #  9      1.13        1.00   # 10      1.27        1.27   # 11      1.41        1.56
   # 14      1.69        2.25   # 18      2.26        4.00

   Confinement: Tied; #3 ties with #10 bars,  #4 with larger bars.
   phi(a) = 0.8,  phi(b) = 0.9,  phi(c) = 0.65

   Pattern: Irregular

   Total steel area, As = 19.84 in^2 at 0.55%

   Area in^2   X (in)   Y (in)  Area in^2   X (in)   Y (in)  Area in^2   X (in)   Y (in)
   --------- -------- -------- --------- -------- -------- --------- -------- --------
        3.72   -141.0      0.0      8.06   -125.0      0.0      8.06    145.0      0.0

Load Combinations:
==================
   U1  =  1.400*Dead + 0.000*Live + 0.000*Wind + 0.000*EarthQuake
   U2  =  1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake
   U3  =  1.200*Dead + 1.000*Live + 0.000*Wind + 0.000*EarthQuake
   U4  =  1.200*Dead + 0.000*Live + 0.800*Wind + 0.000*EarthQuake
   U5  =  1.200*Dead + 1.000*Live + 1.600*Wind + 0.000*EarthQuake
   U6  =  0.900*Dead + 0.000*Live + 1.600*Wind + 0.000*EarthQuake
   U7  =  1.200*Dead + 0.000*Live - 0.800*Wind + 0.000*EarthQuake
   U8  =  1.200*Dead + 1.000*Live - 1.600*Wind + 0.000*EarthQuake
   U9  =  0.900*Dead + 0.000*Live - 1.600*Wind + 0.000*EarthQuake
   U10 =  1.200*Dead + 1.000*Live + 0.000*Wind + 1.000*EarthQuake
   U11 =  0.900*Dead + 0.000*Live + 0.000*Wind + 1.000*EarthQuake
   U12 =  1.200*Dead + 1.000*Live + 0.000*Wind - 1.000*EarthQuake
   U13 =  0.900*Dead + 0.000*Live + 0.000*Wind - 1.000*EarthQuake
```

Service Loads:

No.	Load Case	Axial Load kip	Mx @ Top k-ft	Mx @ Bot k-ft	My @ Top k-ft	My @ Bot k-ft
1	Dead	170.1	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	4.4	0.0	0.0	2496.0	2496.0
	E.Q.	0.0	0.0	0.0	0.0	0.0
2	Dead	170.1	0.0	0.0	0.0	0.0
	Live	35.2	0.0	0.0	0.0	0.0
	Wind	14.4	0.0	0.0	111.8	111.8
	E.Q.	0.0	0.0	0.0	0.0	0.0

Factored Loads and Moments with Corresponding Capacities: (see user's manual for notation)

NOTE: Each loading combination includes the following cases:
First line - at column top
Second line - at column bottom

No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	fMnx k-ft	fMny k-ft	fMn/Mu
1	1 U1	238.1	0.0	0.0	451.7	0.0	999.999
2		238.1	0.0	0.0	451.7	0.0	999.999
3	1 U2	260.4	0.0	0.0	453.5	0.0	999.999
4		260.4	0.0	0.0	453.5	0.0	999.999
5	1 U3	239.3	0.0	0.0	451.8	0.0	999.999
6		239.3	0.0	0.0	451.8	0.0	999.999
7	1 U4	207.7	0.0	1996.8	-0.0	17002.9	8.515
8		207.7	0.0	-1996.8	0.0	-12849.1	6.435
9	1 U5	246.4	0.0	3993.6	-0.0	17432.9	4.365
10		246.4	0.0	-3993.6	0.0	-13265.3	3.322
11	1 U6	160.2	0.0	3993.6	-0.0	16465.2	4.123
12		160.2	0.0	-3993.6	0.0	-12338.8	3.090
13	1 U7	200.6	0.0	-1996.8	0.0	-12772.6	6.397
14		200.6	0.0	1996.8	-0.0	16922.7	8.475
15	1 U8	232.2	0.0	-3993.6	0.0	-13112.5	3.283
16		232.2	0.0	3993.6	-0.0	17275.4	4.326
17	1 U9	146.0	0.0	-3993.6	0.0	-12186.6	3.052
18		146.0	0.0	3993.6	-0.0	16300.5	4.082
19	1 U10	239.3	0.0	0.0	451.8	0.0	999.999
20		239.3	0.0	0.0	451.8	0.0	999.999
21	1 U11	153.1	0.0	0.0	444.2	0.0	999.999
22		153.1	0.0	0.0	444.2	0.0	999.999
23	1 U12	239.3	0.0	0.0	451.8	0.0	999.999
24		239.3	0.0	0.0	451.8	0.0	999.999
25	1 U13	153.1	0.0	0.0	444.2	0.0	999.999
26		153.1	0.0	0.0	444.2	0.0	999.999
27	2 U1	238.1	0.0	0.0	451.7	0.0	999.999
28		238.1	0.0	0.0	451.7	0.0	999.999
29	2 U2	260.4	0.0	0.0	453.5	0.0	999.999
30		260.4	0.0	0.0	453.5	0.0	999.999
31	2 U3	239.3	0.0	0.0	451.8	0.0	999.999
32		239.3	0.0	0.0	451.8	0.0	999.999
33	2 U4	215.7	0.0	89.5	-0.0	17091.9	191.047
34		215.7	0.0	-89.5	0.0	-12934.9	144.582
35	2 U5	262.4	0.0	178.9	-0.0	17608.7	98.412
36		262.4	0.0	-178.9	0.0	-13436.6	75.095
37	2 U6	176.2	0.0	178.9	-0.0	16649.2	93.050
38		176.2	0.0	-178.9	0.0	-12510.5	69.919
39	2 U7	192.6	0.0	-89.5	0.0	-12686.8	141.809
40		192.6	0.0	89.5	-0.0	16833.3	188.157
41	2 U8	216.2	0.0	-178.9	0.0	-12941.0	72.325
42		216.2	0.0	178.9	-0.0	17098.2	95.559
43	2 U9	130.0	0.0	-178.9	0.0	-12014.4	67.147
44		130.0	0.0	178.9	-0.0	16114.5	90.061
45	2 U10	239.3	0.0	0.0	451.8	0.0	999.999
46		239.3	0.0	0.0	451.8	0.0	999.999
47	2 U11	153.1	0.0	0.0	444.2	0.0	999.999
48		153.1	0.0	0.0	444.2	0.0	999.999
49	2 U12	239.3	0.0	0.0	451.8	0.0	999.999
50		239.3	0.0	0.0	451.8	0.0	999.999
51	2 U13	153.1	0.0	0.0	444.2	0.0	999.999
52		153.1	0.0	0.0	444.2	0.0	999.999

*** Program completed as requested! ***