Sallie Mae Headquarters
Reston, VA

Frank Burke
Structural Option
Technical Assignment #3
Thesis Advisor – Thomas E. Boothby

Executive Summary

Sallie Mae HQ is an office / parking structure that is located in Reston, Virginia. The office building is a steel tower structure that extends 9 stories above ground level and is approximately 25,000 SF in area per floor. The steel tower braced frames line up with the parking garage shear walls. The connection between the shear walls and the braced frames are considered pinned connections and keep a continuous load path all the way down to the foundation. The foundation must be designed to resist uplift, and therefore a continuous footing along the shear wall length is the appropriate design.

To determine the lateral forces on the building I used ASCE 7-02. The wind and seismic forces were relatively close, and each one had to be analyzed separately to determine which one caused the larger internal forces and drifts.

I began analyzing the structure by assuming that the 8 braced frames took all the lateral loads in the building. Even though other factors may contribute to the lateral stability of the system, Sallie Mae mainly consists of leaning columns and this approach is conservative. Each of the 8 frames with all there member sizes were drawn into ETABS to determine the relative stiffness between each frame at each floor level. After these relative stiffness' were found, then a series of calculations were made to determine the final story shears in each braced frame at each floor level. Due to the fact that the center of mass (seismic) and the center of area (wind) match up reasonably well with the center of rigidity, the moment caused by a 5% eccentricity had to be considered. Furthermore, both counterclockwise and clockwise moments had to be considered do to this eccentricity. So the final story shears considered both seismic and wind, for both types of moments. Then the largest shears for each frame were reverted back to story forces so a determination of drift and strength could be made by used ETABS again with the new loading.

According to reasonable judgment the drift standards for Sallie Mae were made out to be H/400. With the outstanding height of the building being about 137', the deflection limit comes out to be 4.11 inches. Also the usual practice for multistory building is to keep the drift index within .0015 and .0030 radians for the worst lateral cases.

The effect of the shear walls and braced framing allows for leaning columns throughout the structure; which allows for great simplification of the column loads, and the foundation loads. Overall the lateral system of the existing building is acceptable in the E-W direction. However, in the N-S direction a more in depth analysis needs to be considered.

Table of Contents

Description of Sallie Mae

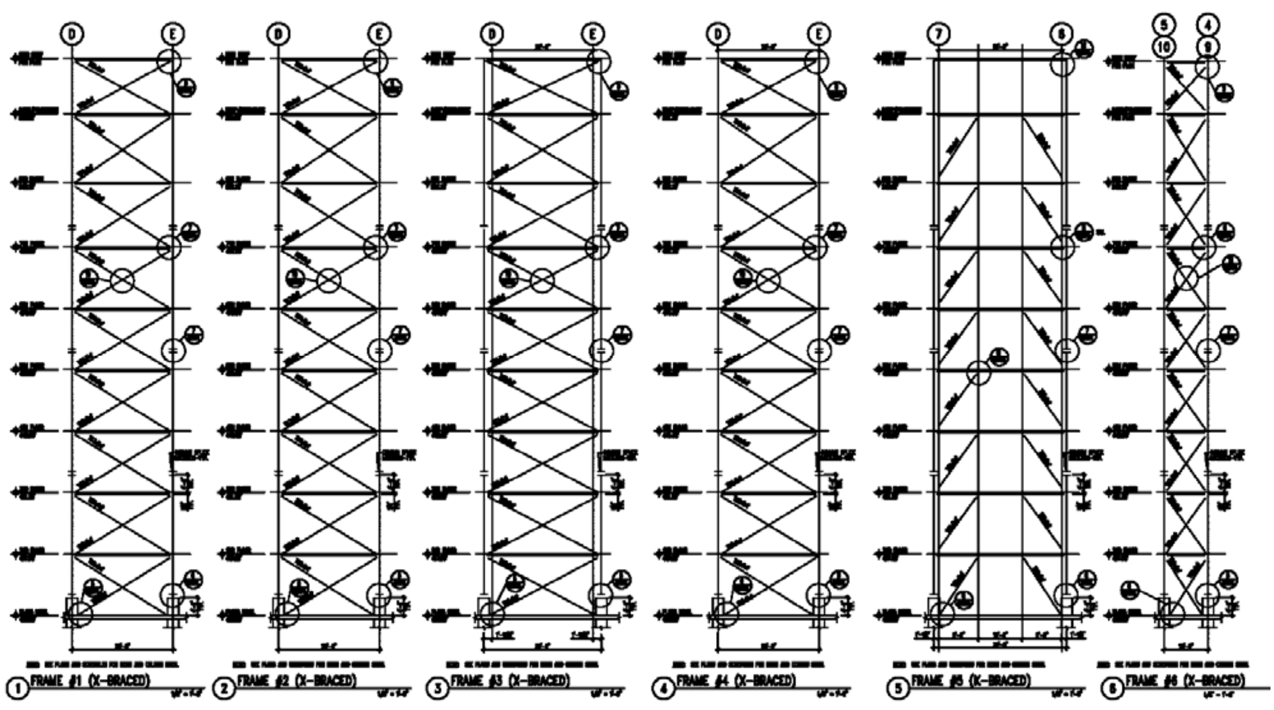
Sallie Mae HQ is an office / parking structure that is located in Reston, Virginia. The office building is a steel tower structure that extends 9 stories above ground level and is approximately 25,000 SF in area per floor. The girders are parallel to the N-S direction which is the long (194') axis of the building and the beams run parallel to the (136') E-W direction. There is a lot of variety in beam sizes but they usually are W24's and W27's. Also, most of them are cambered due to the average 42' span in the E-W direction.

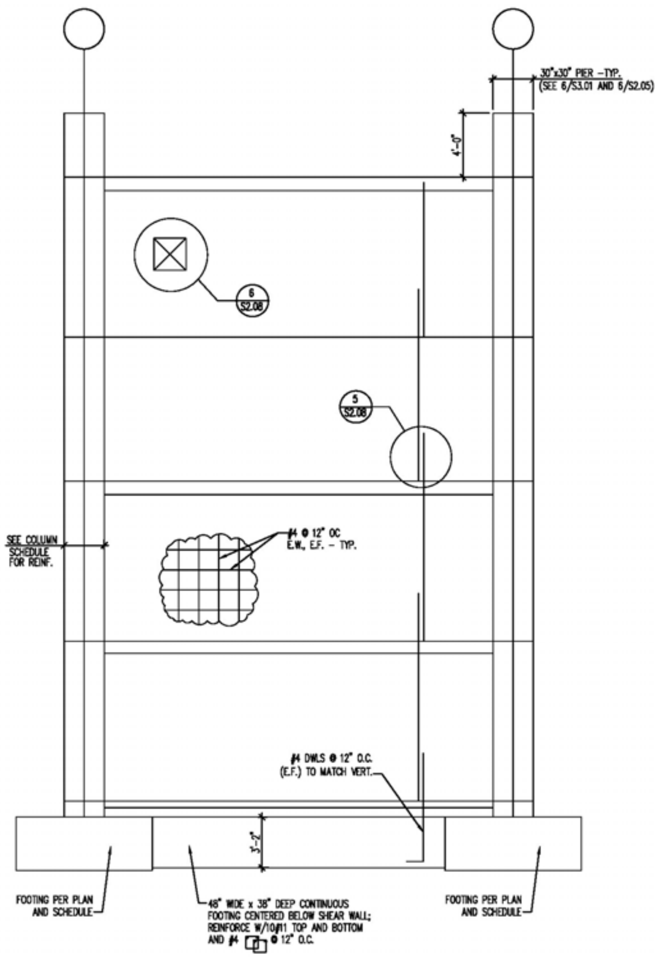
The parking structure is reinforced concrete two-way slabs with drop panels and is about 75,000 SF in area per floor. The average span is approximately 28' and the majority of column sizes are 24" and 30" square columns.

The foundation mostly consists of shallow square footings which can be attributed to great soil conditions at the bottom of the garage.

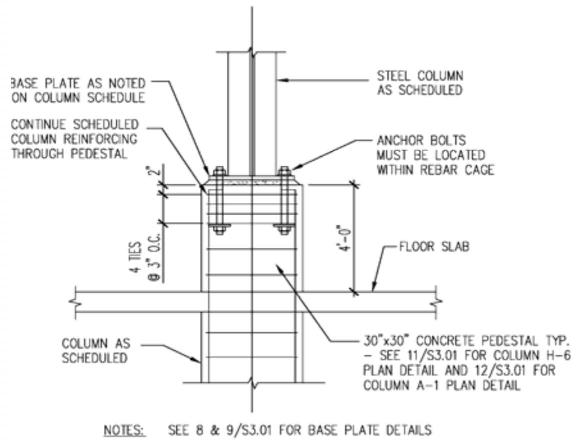
Lateral description of Sallie Mae

Sallie Mae consists of steel tower framing on top of a 5 story underground parking garage. The steel tower braced frames line up with the parking garage shear walls. The connection between the shear walls and the braced frames are considered pinned connections and keep a continuous load path all the way down to the foundation. The foundation must be designed to resist uplift, and therefore a continuous footing along the shear wall length is the appropriate design.





Resistance to overturning



Pin Connection

Lateral analysis of building

To determine the lateral forces on the building I used ASCE 7-02. The wind and seismic forces were relatively close, and each one had to be analyzed separately to determine which one caused the larger internal forces and drifts.

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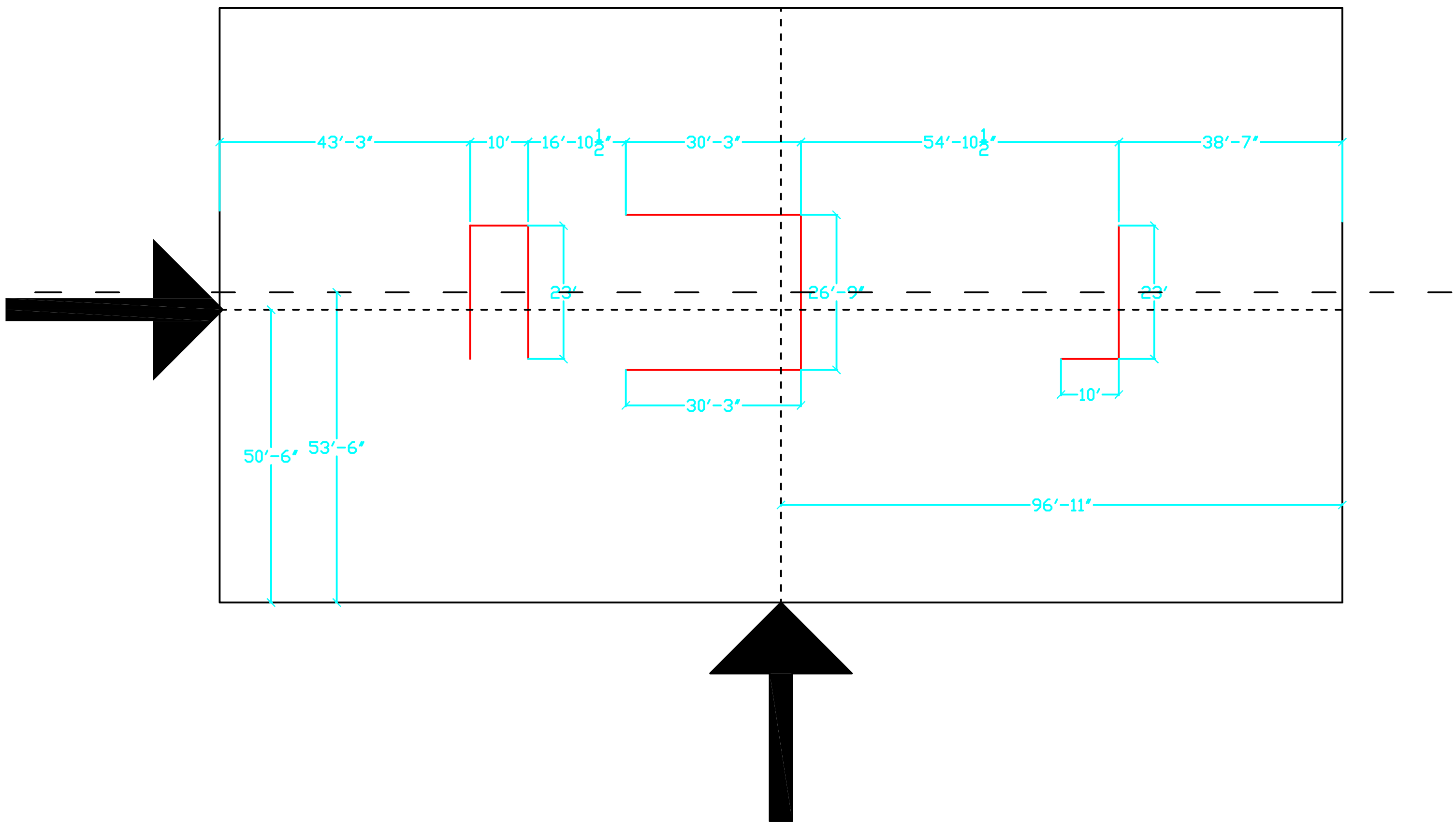
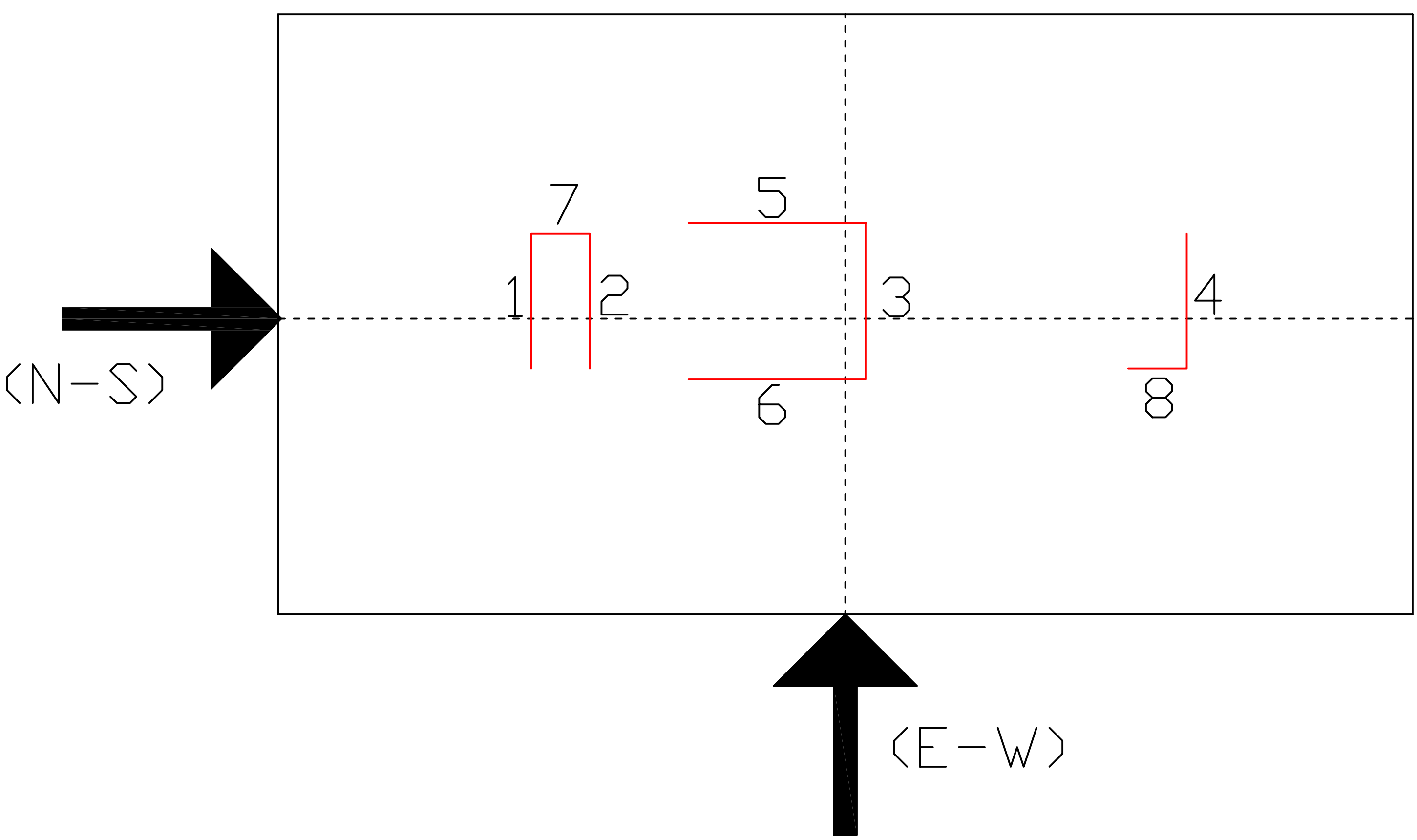

43'-3"
10'
16'-10½"
30'-3"
54'-10½"
38'-7"
23'
26'-9"
23'
30'-3"
10'
50'-6"
53'-6"
96'-11"


7
5
1
2
3
4
6
8
(N-S)
(E-W)

This is a summary of the drifts for each frame.

	Type	Direction	Length (ft)	Max Drift	Controlled	Max Drift Index	Status
Frame #1	Eccentric	E-W	23'	3.33	Seismic	0.0027	ok
Frame #2	Eccentric	E-W	23'	3.22	Seismic	0.0025	ok
Frame #3	Eccentric	E-W	26'-9"	2.96	Seismic	0.0021	ok
Frame #4	Eccentric	E-W	23'	3.57	Seismic	0.0029	ok
Frame #5	Concentric	N-S	30'-3"	6.37	Wind	0.0089	fails
Frame #6	Concentric	N-S	30'-3"	6.37	Wind	0.0089	fails
Frame #7	Eccentric	N-S	10'	6.60	Wind	0.0057	fails
Frame #8	Eccentric	N-S	10'	6.60	Wind	0.0057	fails

As you see these drifts are within the limits for the E-W direction, which is the short direction of the building. However, in the long direction all the frames fail the drift limitation. This makes sense and is reasonable for this analysis, for the following reasons:

- The wind velocity for both directions was considered to be 90mph instead of the previously considered 80mph for the existing design.
- When analyzing seismic, I was very conservative with the weight of the equipment at the penthouse level.
- The weak axis's of the columns resist the lateral forces in the N-S direction and vice versa for the E-W direction.
- The maximum height of the building which only occurs at certain locations was used throughout my analysis.
- The braced frames in both directions were analyzed as resisting the full lateral load of the building; however, if whole frame analyses were performed the deflections would be less. In the E-W direction this really doesn't matter because the deflections were ok. On the other hand, in the N-S direction there are a total of 11 column lines that would be considered in one lateral resisting frame. Even though they are considered as leaning columns, they do add to the stiffness of the structure.

Impact upon foundations

The impact of braced frames and shear walls is considerably large when looking at how columns are designed. Basically, with the exception of a few moment connections within the building, all the columns in the building are considered leaning columns. These don't have to be designed for anything but axial loads.

The same scenario applies to foundation design. Since all these leaning, square columns are framing into the foundation, no moment has to be considered for the foundation design. Therefore, foundation design is very efficient in that regard.

Column check for braced frame #4

One of the critical elements of a braced frame is the columns because of the large tension and compression forces that our caused by the lateral elements. One benefit of these frames is that no shear is transferred into the columns, so the analysis is purely axial forces. I decided to double check column E-10 for frame #4 to make sure it doesn't fail either in tension or compression.
<u>------*note: the impact of leaning columns was not considered*</u>

For wind and seismic causing compression:

Column E-10						
	A_T	A_I	LL	R_{LL}	R_{DL}	DL
Roof	75.00	300.00		2.25	5.85	
PH	780.00	3120.00	32.36			60.84
8	1560.00	6240.00	62.40			121.68
7	2340.00	9360.00	93.60			182.52
6	3120.00	12480.00	124.80			243.36
5	3900.00	15600.00	156.00			304.20
4	4680.00	18720.00	187.20			365.04
3	5460.00	21840.00	218.40			425.88
2	6240.00	24960.00	249.60			486.72
				Total DL + RD		**492.57**
					Wind	**490**
					E	**596**

Load Combinations	
1.4D	689.598
1.2D + 1.6L +.5Lr	991.569
1.2D +1.6Lr + .8W	986.684
1.2D +1.6W +.5L + Lr	1502.134
1.2D + 1.0E + .5L +.2S	1312.334
.9D + 1.6W	1227.313

According to Table 4-2 in the LRFD manual a W14x176 column can support 1940k when kl = 14ft for compression

For wind and seismic causing uplift:

Column E-10						
	A_T	A_I	LL	R_{LL}	R_{DL}	DL
Roof	75.00	300.00		2.25	5.85	
PH	780.00	3120.00	32.36			60.84
8	1560.00	6240.00	62.40			121.68
7	2340.00	9360.00	93.60			182.52
6	3120.00	12480.00	124.80			243.36
5	3900.00	15600.00	156.00			304.20
4	4680.00	18720.00	187.20			365.04
3	5460.00	21840.00	218.40			425.88
2	6240.00	24960.00	249.60			486.72
				Total DL + RD		**492.57**
					Wind	**-490**
					E	**-596**

Load Combinations	
1.4D	689.598
1.2D + 1.6L +.5Lr	991.569
1.2D +1.6Lr + .8W	202.684
1.2D +1.6W +.5L + Lr	-65.866
1.2D + 1.0E + .5L +.2S	120.334
.9D + 1.6W	-340.687

According to Table 4-2 in the LRFD manual a W14x176 column can support 1940k when kl = 14ft for compression, however, even though tension isn't a factor, it will have to be considered for the connection to the parking garage

Bracing check in frame #4:

The values for the tension and compression braces range from 100k to 120k for both earthquake and wind loading. Due to the wind loading having a 1.6 factor, and compression members having buckling issues, the compression member under wind loading will control.

Pu = 1.6 * 101 = 162 k
Member = HSS8 x 8 x .3125
Length = $(23^2 + 14^2)^{.5}$ = 27 ft : k = 1 due to braces have pin-pin connection
kl = 27ft : in Table 4-6 Pu = 167 > 162k ok

Conclusion

Sallie Mae consists of eccentric and concentric bracing in the office structure, and shear walls in the parking structure. The connection between the steel and concrete columns on the first floor is considered a pinned connection. The effect of the shear walls and braced framing allows for leaning columns throughout the structure; which allows for great simplification of the column loads, and the foundation loads.

Overall the lateral system of the existing building is acceptable in the E-W direction. However, in the N-S direction a more in depth analysis needs to be considered.

Appendix 1

Seismic Load Calculations Using Analytical Procedure

Enter Building Properties

	L	B
N-S	136	194
E-W	194	136

Max height 176.100 from foundations

Roof Area 4620 ft^2
Floor Area 26384 ft^2
Parking Area 75000 ft^2
Conversion 1000.000

	Elevation	Floor height	Overall height
Roof	540.100	22.710	176.100
PH	517.390	15.230	153.390
8	502.160	14.660	138.160
7	487.500	14.000	123.500
6	473.500	14.000	109.500
5	459.500	14.000	95.500
4	445.500	14.000	81.500
3	431.500	14.000	67.500
2	417.500	14.000	53.500
P-1	403.500	10.500	39.500
P-2	393.000	9.000	29.000
P-3	384.000	10.000	20.000
P-4	374.000	10.000	10.000
P-5	364.000		Base

Loads

	Total Dead	Upper floor corridor Live	Low Roof Live	High Roof Live	Mechanical Live	Stairs/Lobby Live	Penthouse Total Dead	Penthouse Live	File Room Live	Roof A(ft^2)	Floor A(ft^2)	DL (kips)	25% File Room	10 psf partition	Mechanical	Seismic Weight(kips)
Roof	78			30						4620		360				360
Penthouse			50		150	100	90	150			26384	2375		264	720	3358
8th floor	78	80	50		150	100					26384	2058		264	65	2387
7th floor	78	80			150	100			250		26384	2058	117	264	65	2503
6th floor	78	80			150	100					26384	2058		264	65	2387
5th floor	78	80			150	100					26384	2058		264	65	2387
4th floor	78	80			150	100					26384	2058		264	65	2387
3rd floor	78	80			150	100					26384	2058		264	65	2387
2nd floor	78	80			150	100					26384	2058		264	65	2387
P-1(Base)	150				150	100					75000	11250			65	11315
P-2	150				150	100					75000	11250			65	11315
P-3	150				150	100					75000	11250			65	11315
P-4	150				150	100					75000	11250			65	11315
P-5	150				150	100					75000	11250			65	11315

Effective areas to include live load in seismic weight

PH	4800
Mechanical	432
File Room	1866

The Occupancy Category (Table 1-1)	3
Seismic Use Group (Table 9.1.3)	2
Importance Factor (9.1.4)	1.25
Site Classification (Table 9.4.1.2)	B
S_s (Figure 9.4.1.1(a))	0.195
S_1 (Figure 9.4.1.1(b))	0.070
Fa (Table 9.4.1.2.4a)	1.000
F_v (Table 9.4.1.2.4b)	1.000
$S_{ms}=F_aS_s$ (Eq. 9.4.1.2.4-1)	0.195
$S_{m1}=F_vS_1$ (Eq. 9.4.1.2.4-2)	0.070
$S_{DS}=2/3*S_{MS}$ (Eq. 9.4.1.2.4-1)	0.130
$S_{D1}=2/3*S_{M1}$ (Eq. 9.4.1.2.4-2)	0.047

N-S direction		*E-W direction*	
R_{N-S}	7.000	R_{E-W}	5.000
T(N-S)	1.450	T(E-W)	0.967
$C_{s(N-S)}$	0.023	$C_{s(E-W)}$	0.033
$C_{s\ max(N-S)}$	0.006	$C_{s\ max(E-W)}$	0.012
$C_{s\ min}$	0.007	$C_{s\ min}$	0.007
k(N-S direction)	1.475	k(E-W direction)	1.233
V(N-S direction)	378.102	V(E-W direction)	794.014

Level	w_x	h_x	$w_xh_x^{1.318}$	$w_xh_x^{1.128}$	C_{vx}(N-S)	C_{vx}(E-W)	F_x(N-S)	F_x(E-W)	M_x(N-S)	M_x(E-W)
Roof	360	176	740465	212172	0.028	0.023	11	19	1871.45	3283.16
PH	3358	153	5629225	1667730	0.214	0.185	81	147	12392.57	22478.46
8	2387	138	3428484	1041733	0.130	0.115	49	92	6798.30	12646.85
7	2503	124	3047624	951460	0.116	0.105	44	84	5401.87	10325.26
6	2387	110	2433110	782025	0.092	0.087	35	69	3823.77	7524.52
5	2387	96	1988491	660606	0.075	0.073	29	58	2725.48	5543.57
4	2387	82	1573866	543285	0.060	0.060	23	48	1840.95	3890.71
3	2387	68	1191855	430594	0.045	0.048	17	38	1154.63	2553.97
2	2387	54	845882	323262	0.032	0.036	12	28	649.50	1519.68
P-1	11315	40	2563431	1054175	0.097	0.117	37	93	1453.23	3658.92
P-2	11315	29	1625031	720095	0.062	0.080	23	63	676.36	1834.98
P-3	11315	20	939343	455361	0.036	0.050	13	40	269.63	800.26
P-4	11315	10	337885	193669	0.013	0.021	5	17	48.49	170.18
P-5										
Total W	65800.729		Σ= 26344692.44	Σ= 9036166.82	Σ= 1.00	Σ= 1.00	Σ= 378.10	Σ= 794.01	Σ= 39106.21	Σ= 76230.52

Appendix 2

Project: Sallie Mae | Engineer: FB
Job No: 2003 003 | Last Update: ###########

Description: ASCE - 7 '02 minimum E-W lateral WALL wind loads

Total Building Height	136.61	ft.	OK
Design Wind Speed	90	mph	AISC Figure 6.1
L	136	ft	Horizontal dim. of bldg, parallel to wind
B	194	ft	Horizontal dim. of bldg, normal to wind

Exposure Category	B	ASCE7 - 6.5.6.3	Kd	0.85	ASCE7 - Table 6-4
Importance Factor	1.15	ASCE7 - Table 6-1	Kzt	1	ASCE7 - Figure 6-4
GCpi	-0.18	ASCE7 - Table 6-7			

Cpw, windward wall	0.8	ASCE7 - figure 6-6	use with qz
Cpl, leeward wall	-0.5	ASCE7 - figure 6-6	use with qh
Cps, side wall	-0.7	ASCE7 - figure 6-6	use with qh

ASCE - Table 6-2

α	7
zg (ft)	1200
zmin (ft)	30
c	0.3
L (ft)	320
εbar	1/3
bbar	0.45
abar	0.25

6.5.8 Gust Effect Factor - For Rigid Structures

zbar	81.966
Lzbar	433
Q	0.81
Izbar	0.26
G	0.88

Leeward wall pressure

qh	21.9
pl (+GCpi)	-13.5
pl (-GCpi)	-5.6

Side wall pressure

qh	21.9
pl (+GCpi)	-17.4
pl (-GCpi)	-9.5

Check for flexible building ASCE7 - 6.5.8.2
Fundamental period from seismic analysis

n_1 0.4

β = damping ratio, percent of critical 0.03

Vz = mean hourly wind speed (ft/sec) at height z

$Vz = bbar(zbar/33)^{abar}V(88/60)$

Vz 109.3699

$g_R = sqrt(2*ln(3600n1) + .577/sqrt(2*ln(3600n1)$

g_R 3.965058

$N_1 = n_1L_z/V_z$

N_1 1.584962

$R_n = 7.47\ N_1 /(1 + 10.3N_1)^{5/3}$

R_n 0.102066

$R_\ell = (1/n)-(1/2n^2)*(1-e^{-2n})$ for n > 0

$R_\ell = 1$ for n = 0

		R(?)	n
For R_h	$n = 4.6n_1h / Vz$	0.341404	2.2982777
For R_B	$n = 4.6n_1B / Vz$	0.259523	3.2637865
For R_L	$n = 15.4n_1L / Vz$	0.122029	7.6598771

$R = sqrt(1/β *R_nR_hR_B(0.53 + 0.47R_L)$

R 0.420776

$Gf = .925 ((1 + 1.7Iz(sqrt(g_Q^2Q^2 + g_R^2R^2)/(1 + 1.7g_VI_z))$

Gf 0.875797

Building Extents						
Story	Min X	Max X	Length	Min Y	Max Y	Length
ROOF	33.75	128.34	94.59	36.33	150.33	114.00
RF/PENT	16.75	128.25	111.50	-1.00	187.67	188.67
8TH	-1.09	135.84	136.93	-1.00	192.33	193.33
7TH	-1.09	135.84	136.93	-1.00	192.33	193.33
6TH	-1.09	135.84	136.93	-1.00	192.33	193.33
5TH	-1.09	135.84	136.93	-1.00	192.33	193.33
4TH	-1.09	135.84	136.93	-1.00	192.33	193.33
3RD	-1.09	135.84	136.93	-1.00	192.33	193.33
2ND	-1.09	135.84	136.93	-1.00	192.33	193.33

Windward wall pressure

							p (psf)			***F (kip)	OM(kip-ft)	z value
Floor #	Height (ft.)	z (ft.)	*Ae (ft^2)	**Kz	qz (psf)	pw (psf)	(+GCpi)	(-Gcpi)	(Total)	max(p)		above foundation
1	14											
2	14	14	2706.62	0.57	11.6	8.2	4.2	12.1	17.75	48.05	2570.43	53.5
3	14	28	2706.62	0.69	13.9	9.8	5.8	13.7	19.34	52.36	3534.17	67.5
4	14	42	2706.62	0.77	15.6	11.0	7.0	14.9	20.54	55.60	4531.49	81.5
5	14	56	2706.62	0.84	17.0	11.9	8.0	15.8	21.48	58.14	5552.46	95.5
6	14	70	2706.62	0.89	18.1	12.7	8.7	16.6	22.26	60.26	6598.45	109.5
7	14.67	84	2771.386	0.94	19.1	13.4	9.4	17.3	22.94	63.58	7852.13	123.5
8	17.84	98.67	3142.579	0.98	20.0	14.0	10.0	17.9	23.57	74.07	10233.60	138.16
PH	20.1	116.51	3579.07	1.03	20.9	14.7	10.7	18.6	24.25	86.79	13313.04	153.39
Roof		136.61	1145.7	1.08	21.9	15.3	11.4	19.3	24.93	28.56	5030.21	176.1
									Sum	527.41	59216.00	

Total h	136.61

Appendix 3

Project: Sallie Mae   Engineer: FB
Job No: 2003 003   Last Update: ###########

Description: ASCE - 7 '02 minimum N-S lateral WALL wind loads

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G	0.90

Leeward wall pressure

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pl (+GCpi)	-9.8
pl (-GCpi)	-2.0

Side wall pressure

qh	21.9
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Fundamental period from seismic analysis
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$Vz = bbar(zbar/33)^{abar}V(88/60)$
Vz 109.3699

g_R = sqrt(2*ln(3600n1) + .577/sqrt(2*ln(3600n1)
g_R 3.965058

$N_1 = n_1 L_z / V_z$
N_1 1.584962

$R_n = 7.47\ N_1 / (1 + 10.3N_1)^{5/3}$
R_n 0.102066

$R_\ell = (1/n)-(1/2n^2)*(1-e^{-2n})$ for n > 0
$R_\ell = 1$ for n = 0

		R(?)	n
For R_h	$n = 4.6n_1h / Vz$	0.341404	2.2982777
For R_B	$n = 4.6n_1B / Vz$	0.342533	2.2880152
For R_L	$n = 15.4n_1L / Vz$	0.087332	10.926589

$R = sqrt(1/β *R_nR_hR_B(0.53 + 0.47R_L)$
R 0.47665

$Gf = .925 ((1 + 1.7Iz(sqrt(g_Q^2Q^2 + g_R^2R^2)/(1 + 1.7g_VI_z))$
Gf 0.898709

Story	Min X	Max X	Length	Min Y	Max Y	Length
	Building Extents					
ROOF	33.75	128.34	94.59	36.33	150.33	114.00
RF/PENT	16.75	128.25	111.50	-1.00	187.67	188.67
8TH	-1.09	135.84	136.93	-1.00	192.33	193.33
7TH	-1.09	135.84	136.93	-1.00	192.33	193.33
6TH	-1.09	135.84	136.93	-1.00	192.33	193.33
5TH	-1.09	135.84	136.93	-1.00	192.33	193.33
4TH	-1.09	135.84	136.93	-1.00	192.33	193.33
3RD	-1.09	135.84	136.93	-1.00	192.33	193.33
2ND	-1.09	135.84	136.93	-1.00	192.33	193.33

Windward wall pressure

Floor #	Height (ft.)	z (ft.)	*Ae (ft^2)	**Kz	qz (psf)	pw (psf)	p (psf) (+GCpi)	p (psf) (-Gcpi)	p (psf) (Total)	***F (kip) max(p)	OM(kip-ft)	z value above foundation
1	14											
2	14	14	1917.02	0.57	11.6	8.4	4.4	12.3	14.28	27.37	1464.511	53.5
3	14	28	1917.02	0.69	13.9	10.0	6.1	14.0	15.91	30.51	2059.32	67.5
4	14	42	1917.02	0.77	15.6	11.2	7.3	15.2	17.14	32.87	2678.537	81.5
5	14	56	1917.02	0.84	17.0	12.2	8.3	16.1	18.11	34.71	3314.937	95.5
6	14	70	1917.02	0.89	18.1	13.0	9.1	16.9	18.91	36.25	3969.528	109.5
7	14.67	84	1962.892	0.94	19.1	13.7	9.8	17.6	19.61	38.48	4752.772	123.5
8	17.84	98.67	2225.797	0.98	20.0	14.3	10.4	18.3	20.25	45.07	6227.39	138.16
PH	20.1	116.51	2115.155	1.03	20.9	15.0	11.1	19.0	20.95	44.31	6796.539	153.39
Roof		136.61	950.6295	1.08	21.9	15.7	11.8	19.7	21.65	20.58	3624.032	176.1
									sum	310.16	34887.57	

Total h 136.61

Appendix 4

Design Loads(E-W)						
Wind				Seismic		
Floor #	***F (kip)	OM(kip-ft)		Floor #	Fx(E-W)	Mx(E-W)
Roof	45.7	8048.3		Roof	18.64	3283.16
PH	138.9	21300.9		PH	146.54	22478.46
8	118.5	16373.8		8	91.54	12646.85
7	101.7	12563.4		7	83.61	10325.26
6	96.4	10557.5		6	68.72	7524.52
5	93.0	8883.9		5	58.05	5543.57
4	89.0	7250.4		4	47.74	3890.71
3	83.8	5654.7		3	37.84	2553.97
2	76.9	4112.7		2	28.41	1519.68
1				P-1	92.63	3658.92
Sum	843.9	94745.6		P-2	63.28	1834.98
				P-3	40.01	800.26
				P-4	17.02	170.18
				P-5		
				Sum	794.01	76230.52

Design Loads(N-S)						
Wind				Seismic		
Floor #	***F (kip)	OM(kip-ft)		Floor #	Fx(N-S)	Mx(N-S)
Roof	32.9	5798.5		Roof	10.6	1871.5
PH	70.9	10874.5		PH	80.8	12392.6
8	72.1	9963.8		8	49.2	6798.3
7	61.6	7604.4		7	43.7	5401.9
6	58.0	6351.2		6	34.9	3823.8
5	55.5	5303.9		5	28.5	2725.5
4	52.6	4285.7		4	22.6	1840.9
3	48.8	3294.9		3	17.1	1154.6
2	43.8	2343.2		2	12.1	649.5
1				P-1	36.8	1453.2
Sum	496.3	55820.1		P-2	23.3	676.4
				P-3	13.5	269.6
				P-4	4.8	48.5
				P-5		
				Sum	378.1	39106.2

1.6

E-W	Base	2	3	4	5	6	7	8	9	10
Force	0.0	28.4	37.8	47.7	58.0	68.7	83.6	91.5	146.5	18.6
Story Shear	581.07679	581.07679	552.67156	514.83502	467.09627	409.04837	340.33132	256.7259	165.1882	18.6437

N-S	Base	2	3	4	5	6	7	8	9	10
Force	0.0	12.1	17.1	22.6	28.5	34.9	43.7	49.2	80.8	10.6
Story Shear	299.65762	299.65762	287.51743	270.4118	247.8235	219.28447	184.36422	140.6244	91.41845	10.62723

Deflection

	Base	2	3	4	5	6	7	8	9	10
1	0	0.01	0.023	0.038	0.055	0.072	0.092	0.112	0.132	0.148
2	0	0.01	0.025	0.042	0.062	0.084	0.108	0.133	0.159	0.179
3	0	0.009	0.02	0.031	0.044	0.057	0.07	0.084	0.1	0.119
4	0	0.01	0.021	0.035	0.051	0.069	0.087	0.106	0.126	0.142
5	0	0.032	0.062	0.092	0.119	0.144	0.167	0.185	0.206	0.551
6	0	0.032	0.062	0.092	0.119	0.144	0.167	0.185	0.206	0.551
7	0	0.025	0.073	0.146	0.24	0.353	0.48	0.624	0.767	0.952
8	0	0.025	0.073	0.146	0.24	0.353	0.48	0.624	0.767	0.952

Braced Frames
Stiffenes 1/Delta

	Base	2	3	4	5	6	7	8	9
1	100.00	76.92	66.67	58.82	58.82	50.00	50.00	50.00	62.50
2	100.00	66.67	58.82	50.00	45.45	41.67	40.00	38.46	50.00
3	111.11	90.91	90.91	76.92	76.92	76.92	71.43	62.50	52.63
4	100.00	90.91	71.43	62.50	55.56	55.56	52.63	50.00	62.50
5	31.25	33.33	33.33	37.04	40.00	43.48	55.56	47.62	2.90
6	31.25	33.33	33.33	37.04	40.00	43.48	55.56	47.62	2.90

7	40.00	20.83	13.70	10.64	8.85	7.87	6.94	6.99	5.41
8	40.00	20.83	13.70	10.64	8.85	7.87	6.94	6.99	5.41

Braced Frames

Relative Stiffenes 1/Delta/5.41

	Base	2	3	4	5	6	7	8	9
1	18.50	14.23	12.33	10.88	10.88	9.25	9.25	9.25	11.56
2	18.50	12.33	10.88	9.25	8.41	7.71	7.40	7.12	9.25
3	20.56	16.82	16.82	14.23	14.23	14.23	13.21	11.56	9.74
4	18.50	16.82	13.21	11.56	10.28	10.28	9.74	9.25	11.56
5	5.78	6.17	6.17	6.85	7.40	8.04	10.28	8.81	0.54
6	5.78	6.17	6.17	6.85	7.40	8.04	10.28	8.81	0.54
7	7.40	3.85	2.53	1.97	1.64	1.46	1.28	1.29	1.00
8	7.40	3.85	2.53	1.97	1.64	1.46	1.28	1.29	1.00
Sum E-W	76.06	60.20	53.25	45.93	43.80	41.47	39.60	37.18	42.11
Sum N-S	26.36	20.04	17.40	17.64	18.07	19.00	23.13	20.21	3.07

Proportions for direct shear

	Base	2	3	4	5	6	7	8	9
1	0.24	0.24	0.23	0.24	0.25	0.22	0.23	0.25	0.27
2	0.24	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.22
3	0.27	0.28	0.32	0.31	0.32	0.34	0.33	0.31	0.23
4	0.24	0.28	0.25	0.25	0.23	0.25	0.25	0.25	0.27
5	0.22	0.31	0.35	0.39	0.41	0.42	0.44	0.44	0.17
6	0.22	0.31	0.35	0.39	0.41	0.42	0.44	0.44	0.17
7	0.28	0.19	0.15	0.11	0.09	0.08	0.06	0.06	0.33
8	0.28	0.19	0.15	0.11	0.09	0.08	0.06	0.06	0.33

Direct Shear

	Base	2	3	4	5	6	7	8	9
1	141.34	130.65	119.25	110.68	101.63	75.92	59.97	41.10	5.12
2	141.34	113.23	105.22	94.08	78.53	63.26	47.97	31.61	4.10
3	157.05	154.40	162.61	144.74	132.90	116.80	85.67	51.37	4.31
4	141.34	154.40	127.76	117.60	95.98	84.35	63.12	41.10	5.12
5	65.71	88.47	95.83	96.26	89.78	78.05	62.50	39.86	1.85
6	65.71	88.47	95.83	96.26	89.78	78.05	62.50	39.86	1.85
7	84.11	55.29	39.38	27.65	19.86	14.13	7.81	5.85	3.46
8	84.11	55.29	39.38	27.65	19.86	14.13	7.81	5.85	3.46

Max heights for each floor level (in)

0	168	336	504	672	840	1008	1183.92	1396.8	1638

	Base moment(k-in)
1	134683.101
2	116228.645
3	172952.933
4	142290.643
5	106295.019
6	106295.019
7	43847.4862
8	43847.4862

Center of Rigidity calculation

	x(in)								
1	519	519	519	519	519	519	519	519	519
2	639	639	639	639	639	639	639	639	639
3	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5
4	1863	1863	1863	1863	1863	1863	1863	1863	1863
	y(in)								
5	481.5	481.5	481.5	481.5	481.5	481.5	481.5	481.5	481.5
6	802.5	802.5	802.5	802.5	802.5	802.5	802.5	802.5	802.5
7	504	504	504	504	504	504	504	504	504
8	780	780	780	780	780	780	780	780	780

		Base	2	3	4	5	6	7	8	9
	Rx_i									
	1	9601.5	7385.7692	6401	5647.9412	5647.9412	4800.75	4800.75	4800.75	6000.938
	2	11821.5	7881	6953.8235	5910.75	5373.4091	4925.625	4728.6	4546.7308	5910.75
	3	24759.1667	20257.5	20257.5	17140.962	17140.962	17140.962	15916.607	13927.031	11728.03
	4	34465.5	31332.273	24618.214	21540.938	19147.5	19147.5	18139.737	17232.75	21540.94
Sum		80647.6667	66856.542	58230.538	50240.59	47309.812	46014.837	43585.694	40507.262	45180.65
x_{cr}(in)		1060.37838	1110.5652	1093.5691	1093.9556	1080.1329	1109.6768	1100.6175	1089.5526	1072.873
x_{cr}(ft)		88.3648649	92.547099	91.130762	91.162964	90.011076	92.47307	91.718124	90.796053	89.40607
	5	2783.67188	2969.25	2969.25	3299.1667	3563.1	3872.9348	4948.75	4241.7857	258.1957
	6	4639.45313	4948.75	4948.75	5498.6111	5938.5	6454.8913	8247.9167	7069.6429	430.3261
	7	3729.6	1942.5	1277.2603	991.91489	825.13274	734.17323	647.5	652.02797	504
	8	5772	3006.25	1976.7123	1535.1064	1276.9912	1136.2205	1002.0833	1009.0909	780
Sum		16924.725	12866.75	11171.973	11324.799	11603.724	12198.22	14846.25	12972.547	1972.522
y_{cr}(in)		642	642	642	642	642	642	642	642	642
y_{cr}(ft)		53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5

Torsional Moment due to eccentricity

E-W	Base	2	3	4	5	6	7	8	9
Force	59631.0421	28979.23	35745.438	32250.395	33896.646	18147.543	16015.208	12132.639	1680.304
5% ecc	67579.2302	64275.703	59875.313	54323.296	47572.326	39580.533	29857.227	19211.389	2168.262

N-S	Base	2	3	4	5	6	7	8	9
Force	-10787.674	-10350.627	-9734.8247	-8921.6462	-7894.241	-6637.112	-5062.4787	-3291.0642	-382.5802
5% ecc	24452.0615	23461.422	22065.603	20222.398	17893.613	15044.121	11474.952	7459.7455	867.1818

Eccentric Shear Calculation

	Base	2	3	4	5	6	7	8	9
	x	x	x	x	x	x	x	x	x
1	541.38	591.57	574.57	574.96	561.13	590.68	581.62	570.55	553.87
2	421.38	471.57	454.57	454.96	441.13	470.68	461.62	450.55	433.87
3	-144.12	-93.93	-110.93	-110.54	-124.37	-94.82	-103.88	-114.95	-131.63
4	-802.62	-752.43	-769.43	-769.04	-782.87	-753.32	-762.38	-773.45	-790.13
	y	y	y	y	y	y	y	y	y
5	160.50	160.50	160.50	160.50	160.50	160.50	160.50	160.50	160.50
6	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50
7	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00
8	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00

	Base	2	3	4	5	6	7	8	9
	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
1	10016	8418	7086	6257	6106	5464	5380	5278	6404
2	7796	5816	4947	4208	3710	3628	3416	3206	4013
3	-2963	-1580	-1866	-1573	-1770	-1349	-1373	-1329	-1282
4	-14849	-12655	-10167	-8892	-8046	-7742	-7423	-7154	-9136
	Ry	Ry	Ry	Ry	Ry	Ry	Ry	Ry	Ry
5	928	990	990	1100	1188	1291	1650	1414	86
6	-928	-990	-990	-1100	-1188	-1291	-1650	-1414	-86
7	1021	532	350	272	226	201	177	179	138
8	-1021	-532	-350	-272	-226	-201	-177	-179	-138

		Base	2	3	4	5	6	7	8	9
		Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2
	1	5422175	4980049	4071600	3597422	3426528	3227317	3129080	3011155	3547087
	2	3284855	2742609	2248654	1914607	1636394	1707679	1576871	1444407	1741272
	3	426960	148399	206959	173901	220110	127955	142603	152774	168698
	4	11917727	9521751	7823172	6838402	6299053	5832596	5659316	5533543	7218480
Sum		21051718	17392808	14350385	12524332	11582086	10895546	10507870	10141879	12675537
		Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2
	5	148926	158855	158855	176505	190626	207202	264758	226936	13813
	6	148926	158855	158855	176505	190626	207202	264758	226936	13813
	7	140926	73399	48262	37480	31178	27741	24466	24637	19044
	8	140926	73399	48262	37480	31178	27741	24466	24637	19044
Sum		579704	464507	414234	427971	443608	469887	578449	503146	65715

Both counterclockwise and clockwise moment will be considered due to 5% eccentricity

Eccentric Shear for E-W (kip)

For counterclockwise moment; positive values mean resistance in the positive y direction, otherwise its the negative y direction; and vice versa for negative values

	Base	2	3	4	5	6	7	8	9
1	32.1513	31.1106	29.5670	27.1387	25.0817	19.8483	15.2867	9.9972	1.0955
2	25.0247	21.4931	20.6399	18.2533	15.2365	13.1800	9.7062	6.0727	0.6865
3	-9.5101	-5.8383	-7.7842	-6.8233	-7.2694	-4.9020	-3.9005	-2.5176	-0.2192
4	-47.6660	-46.7654	-42.4226	-38.5687	-33.0487	-28.1263	-21.0924	-13.5523	-1.5628

For counterclockwise moment; positive values mean resistance in the negative x direction, otherwise its the positive x direction; and vice versa for negative values

5	108.1692	136.9556	143.0630	139.5901	127.3684	108.7446	85.1449	53.9874	2.8397
6	-108.1692	-136.9556	-143.0630	-139.5901	-127.3684	-108.7446	-85.1449	-53.9874	-2.8397
7	119.0468	73.5976	50.5510	34.4742	24.2285	16.9331	9.1511	6.8168	4.5533
8	-119.0468	-73.5976	-50.5510	-34.4742	-24.2285	-16.9331	-9.1511	-6.8168	-4.5533

Direct Shear for E-W (kip)

positive value means that its resisting in the negative y direction

	Base	2	3	4	5	6	7	8	9
1	141.34	130.65	119.25	110.68	101.63	75.92	59.97	41.10	5.12
2	141.34	113.23	105.22	94.08	78.53	63.26	47.97	31.61	4.10
3	157.05	154.40	162.61	144.74	132.90	116.80	85.67	51.37	4.31
4	141.34	154.40	127.76	117.60	95.98	84.35	63.12	41.10	5.12
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0

Eccentric Shear for N-S (kip)

For counterclockwise moment; positive values mean resistance in the positive y direction, otherwise its the negative y direction; and vice versa for negative values

	Base	2	3	4	5	6	7	8	9
1	11.6332	11.3557	10.8962	10.1026	9.4341	7.5441	5.8751	3.8819	0.4381
2	9.0547	7.8453	7.6063	6.7950	5.7310	5.0096	3.7304	2.3580	0.2746
3	-3.4410	-2.1310	-2.8687	-2.5401	-2.7343	-1.8632	-1.4991	-0.9776	-0.0877
4	-17.2469	-17.0700	-15.6338	-14.3576	-12.4308	-10.6905	-8.1064	-5.2623	-0.6250

For counterclockwise moment; positive values mean resistance in the negative x direction, otherwise its the positive x direction; and vice versa for negative values

5	39.1387	49.9905	52.7224	51.9638	47.9077	41.3326	32.7235	20.9632	1.1357
6	-39.1387	-49.9905	-52.7224	-51.9638	-47.9077	-41.3326	-32.7235	-20.9632	-1.1357
7	43.0745	26.8640	18.6294	12.8334	9.1132	6.4361	3.5170	2.6469	1.8211
8	-43.0745	-26.8640	-18.6294	-12.8334	-9.1132	-6.4361	-3.5170	-2.6469	-1.8211

Direct Shear for N-S (kip)

positive value means that its resisting in the negative x direction

	Base	2	3	4	5	6	7	8	9
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	65.71	88.47	95.83	96.26	89.78	78.05	62.50	39.86	1.85
6	65.71	88.47	95.83	96.26	89.78	78.05	62.50	39.86	1.85
7	84.11	55.29	39.38	27.65	19.86	14.13	7.81	5.85	3.46
8	84.11	55.29	39.38	27.65	19.86	14.13	7.81	5.85	3.46

For counterclockwise moments

Total Shear for E-W direction

positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	141.3430	130.6459	119.2460	110.6813	101.6304	75.9176	59.9658	41.0995	5.1189
2	141.3430	113.2264	105.2171	94.0791	78.5325	63.2646	47.9727	31.6150	4.0951
3	166.5579	160.2379	170.3925	151.5604	140.1707	121.6983	89.5660	53.8919	4.5299
4	189.0090	201.1651	170.1862	156.1675	129.0330	112.4792	84.2143	54.6518	6.6817
5	108.1692	136.9556	143.0630	139.5901	127.3684	108.7446	85.1449	53.9874	2.8397
6	-108.1692	-136.9556	-143.0630	-139.5901	-127.3684	-108.7446	-85.1449	-53.9874	-2.8397
7	119.0468	73.5976	50.5510	34.4742	24.2285	16.9331	9.1511	6.8168	4.5533
8	-119.0468	-73.5976	-50.5510	-34.4742	-24.2285	-16.9331	-9.1511	-6.8168	-4.5533

For clockwise moments
Total Shear for E-W direction
positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	173.494287	161.75644	148.81303	137.81995	126.71201	95.765914	75.252549	51.096646	6.214422
2	166.367748	134.71952	125.85697	112.33242	93.769082	76.444657	57.678862	37.687703	4.781662
3	157.04778	154.39965	162.60825	144.73705	132.90124	116.79626	85.665488	51.374324	4.310682
4	141.343002	154.39965	127.76362	117.59885	95.984228	84.352854	63.121939	41.099459	5.118935
5	-108.16921	-136.95562	-143.06303	-139.59006	-127.36838	-108.74456	-85.14494	-53.987401	-2.839719
6	108.169211	136.95562	143.06303	139.59006	127.36838	108.74456	85.14494	53.987401	2.839719
7	-119.04679	-73.597644	-50.551014	-34.474221	-24.228539	-16.933071	-9.1510917	-6.816787	-4.553306
8	119.046788	73.597644	50.551014	34.474221	24.228539	16.933071	9.1510917	6.816787	4.553306

For counterclockwise moments
Total Shear for N-S direction
positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	-11.6332	-11.3557	-10.8962	-10.1026	-9.4341	-7.5441	-5.8751	-3.8819	-0.4381
2	-9.0547	-7.8453	-7.6063	-6.7950	-5.7310	-5.0096	-3.7304	-2.3580	-0.2746
3	3.4410	2.1310	2.8687	2.5401	2.7343	1.8632	1.4991	0.9776	0.0877
4	17.2469	17.0700	15.6338	14.3576	12.4308	10.6905	8.1064	5.2623	0.6250
5	104.8530	138.4574	148.5480	148.2258	137.6872	119.3801	95.2233	60.8194	2.9905
6	65.7144	88.4669	95.8255	96.2620	89.7795	78.0475	62.4997	39.8562	1.8548
7	127.1889	82.1559	58.0097	40.4831	28.9759	20.5707	11.3295	8.5000	5.2799
8	84.1144	55.2918	39.3804	27.6497	19.8627	14.1346	7.8125	5.8530	3.4589

For clockwise moments
Total Shear for N-S direction

	Base	2	3	4	5	6	7	8	9
1	11.6332	11.3557	10.8962	10.1026	9.4341	7.5441	5.8751	3.8819	0.4381
2	9.0547	7.8453	7.6063	6.7950	5.7310	5.0096	3.7304	2.3580	0.2746
3	-3.4410	-2.1310	-2.8687	-2.5401	-2.7343	-1.8632	-1.4991	-0.9776	-0.0877
4	-17.2469	-17.0700	-15.6338	-14.3576	-12.4308	-10.6905	-8.1064	-5.2623	-0.6250
5	65.7143897	88.4669	95.82554	96.262022	89.779512	78.047521	62.499737	39.856214	1.854752
6	104.853045	138.45738	148.54797	148.22584	137.68721	119.38012	95.223274	60.819419	2.990479
7	84.1144188	55.291813	39.380359	27.64973	19.862724	14.13459	7.8124671	5.8530105	3.458862
8	127.188887	82.155858	58.009716	40.483109	28.975923	20.570662	11.329483	8.4999558	5.279926

Max Story Shears to analyze in etabs

	Base	2	3	4	5	6	7	8	9
1	173.494287	161.75644	148.81303	137.81995	126.71201	95.765914	75.252549	51.096646	6.214422
2	166.367748	134.71952	125.85697	112.33242	93.769082	76.444657	57.678862	37.687703	4.781662
3	166.5579	160.2379	170.3925	151.5604	140.1707	121.6983	89.5660	53.8919	4.5299
4	189.0090	201.1651	170.1862	156.1675	129.0330	112.4792	84.2143	54.6518	6.6817
5	108.1692	136.9556	143.0630	139.5901	127.3684	108.7446	85.1449	53.9874	2.8397
6	108.169211	136.95562	143.06303	139.59006	127.36838	108.74456	85.14494	53.987401	2.839719
7	127.1889	82.1559	58.0097	40.4831	28.9759	20.5707	11.3295	8.5000	5.2799
8	127.188887	82.155858	58.009716	40.483109	28.975923	20.570662	11.329483	8.4999558	5.279926

Max seismic story forces to add in etabs

	2	3	4	5	6	7	8	9	10
1	11.74	12.94	10.99	11.11	30.95	20.51	24.16	44.88	6.21
2	31.65	8.86	13.52	18.56	17.32	18.77	19.99	32.91	4.78
3	6.32	-10.15	18.83	11.39	18.47	32.13	35.67	49.36	4.53
4	-12.16	30.98	14.02	27.13	16.55	28.26	29.56	47.97	6.68
5	-28.79	-6.11	3.47	12.22	18.62	23.60	31.16	51.15	2.84
6	-28.79	-6.11	3.47	12.22	18.62	23.60	31.16	51.15	2.84
7	45.03	24.15	17.53	11.51	8.41	9.24	2.83	3.22	5.28
8	45.03	24.15	17.53	11.51	8.41	9.24	2.83	3.22	5.28

Appendix 5

Design Loads(E-W)						
Wind				Seismic		
Floor #	***F (kip)	OM(kip-ft)		Floor #	Fx(E-W)	Mx(E-W)
Roof	45.7	8048.3		Roof	18.64	3283.16
PH	138.9	21300.9		PH	146.54	22478.46
8	118.5	16373.8		8	91.54	12646.85
7	101.7	12563.4		7	83.61	10325.26
6	96.4	10557.5		6	68.72	7524.52
5	93.0	8883.9		5	58.05	5543.57
4	89.0	7250.4		4	47.74	3890.71
3	83.8	5654.7		3	37.84	2553.97
2	76.9	4112.7		2	28.41	1519.68
1				P-1	92.63	3658.92
Sum	843.9	94745.6		P-2	63.28	1834.98
				P-3	40.01	800.26
				P-4	17.02	170.18
				P-5		
				Sum	794.01	76230.52

Design Loads(N-S)						
Wind				Seismic		
Floor #	***F (kip)	OM(kip-ft)		Floor #	Fx(N-S)	Mx(N-S)
Roof	32.9	5798.5		Roof	10.6	1871.5
PH	70.9	10874.5		PH	80.8	12392.6
8	72.1	9963.8		8	49.2	6798.3
7	61.6	7604.4		7	43.7	5401.9
6	58.0	6351.2		6	34.9	3823.8
5	55.5	5303.9		5	28.5	2725.5
4	52.6	4285.7		4	22.6	1840.9
3	48.8	3294.9		3	17.1	1154.6
2	43.8	2343.2		2	12.1	649.5
1				P-1	36.8	1453.2
Sum	496.3	55820.1		P-2	23.3	676.4
				P-3	13.5	269.6
				P-4	4.8	48.5
				P-5		
				Sum	378.1	39106.2

CF 1.6

E-W	Base	2	3	4	5	6	7	8	9	10
Force	0.0	48.0	52.4	55.6	58.1	60.3	63.6	74.1	86.8	28.6
Story Shear	527.41286	527.41286	479.36735	427.00922	371.40806	313.26714	253.00733	189.4273	115.3566	28.56454

N-S	Base	2	3	4	5	6	7	8	9	10
Force	0.0	27.4	30.5	32.9	34.7	36.3	38.5	45.1	44.3	20.6
Story Shear	310.15676	310.15676	282.78272	252.27427	219.40879	184.69741	148.44601	109.962	64.88827	20.5794

Deflection

	Base	2	3	4	5	6	7	8	9	10
1	0	0.01	0.023	0.038	0.055	0.072	0.092	0.112	0.132	0.148
2	0	0.01	0.025	0.042	0.062	0.084	0.108	0.133	0.159	0.179
3	0	0.009	0.02	0.031	0.044	0.057	0.07	0.084	0.1	0.119
4	0	0.01	0.021	0.035	0.051	0.069	0.087	0.106	0.126	0.142
5	0	0.032	0.062	0.092	0.119	0.144	0.167	0.185	0.206	0.551
6	0	0.032	0.062	0.092	0.119	0.144	0.167	0.185	0.206	0.551
7	0	0.025	0.073	0.146	0.24	0.353	0.48	0.624	0.767	0.952
8	0	0.025	0.073	0.146	0.24	0.353	0.48	0.624	0.767	0.952

Braced Frames
Stiffenes 1/Delta

	Base	2	3	4	5	6	7	8	9
1	100.00	76.92	66.67	58.82	58.82	50.00	50.00	50.00	62.50
2	100.00	66.67	58.82	50.00	45.45	41.67	40.00	38.46	50.00
3	111.11	90.91	90.91	76.92	76.92	76.92	71.43	62.50	52.63
4	100.00	90.91	71.43	62.50	55.56	55.56	52.63	50.00	62.50
5	31.25	33.33	33.33	37.04	40.00	43.48	55.56	47.62	2.90
6	31.25	33.33	33.33	37.04	40.00	43.48	55.56	47.62	2.90
7	40.00	20.83	13.70	10.64	8.85	7.87	6.94	6.99	5.41
8	40.00	20.83	13.70	10.64	8.85	7.87	6.94	6.99	5.41

Braced Frames

Relative Stiffenes 1/Delta/5.41

	Base	2	3	4	5	6	7	8	9
1	18.50	14.23	12.33	10.88	10.88	9.25	9.25	9.25	11.56
2	18.50	12.33	10.88	9.25	8.41	7.71	7.40	7.12	9.25
3	20.56	16.82	16.82	14.23	14.23	14.23	13.21	11.56	9.74
4	18.50	16.82	13.21	11.56	10.28	10.28	9.74	9.25	11.56
5	5.78	6.17	6.17	6.85	7.40	8.04	10.28	8.81	0.54
6	5.78	6.17	6.17	6.85	7.40	8.04	10.28	8.81	0.54
7	7.40	3.85	2.53	1.97	1.64	1.46	1.28	1.29	1.00
8	7.40	3.85	2.53	1.97	1.64	1.46	1.28	1.29	1.00
Sum E-W	76.06	60.20	53.25	45.93	43.80	41.47	39.60	37.18	42.11
Sum N-S	26.36	20.04	17.40	17.64	18.07	19.00	23.13	20.21	3.07

Proportions for direct shear

	Base	2	3	4	5	6	7	8	9
1	0.24	0.24	0.23	0.24	0.25	0.22	0.23	0.25	0.27
2	0.24	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.22
3	0.27	0.28	0.32	0.31	0.32	0.34	0.33	0.31	0.23
4	0.24	0.28	0.25	0.25	0.23	0.25	0.25	0.25	0.27
5	0.22	0.31	0.35	0.39	0.41	0.42	0.44	0.44	0.17
6	0.22	0.31	0.35	0.39	0.41	0.42	0.44	0.44	0.17
7	0.28	0.19	0.15	0.11	0.09	0.08	0.06	0.06	0.33
8	0.28	0.19	0.15	0.11	0.09	0.08	0.06	0.06	0.33

Direct Shear

	Base	2	3	4	5	6	7	8	9
1	128.29	113.32	98.90	88.01	77.83	56.44	44.25	28.70	7.84
2	128.29	98.21	87.27	74.81	60.14	47.03	35.40	22.08	6.27
3	142.54	133.92	134.87	115.09	101.78	86.83	63.21	35.88	6.60
4	128.29	133.92	105.97	93.51	73.51	62.71	46.58	28.70	7.84
5	68.02	87.01	89.40	85.22	75.62	62.84	48.87	28.29	3.59
6	68.02	87.01	89.40	85.22	75.62	62.84	48.87	28.29	3.59
7	87.06	54.38	36.74	24.48	16.73	11.38	6.11	4.15	6.70
8	87.06	54.38	36.74	24.48	16.73	11.38	6.11	4.15	6.70

Max heights for each floor level (in)

0	168	336	504	672	840	1008	1183.92	1396.8	1638

Base moment(k-in)

1	110334.054
2	95725.9966
3	140475.118
4	116643.059
5	94128.8357
6	94128.8357
7	42344.3474
8	42344.3474

Center of Rigidity calculation

x(in)

1	519	519	519	519	519	519	519	519	519
2	639	639	639	639	639	639	639	639	639
3	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5	1204.5
4	1863	1863	1863	1863	1863	1863	1863	1863	1863

y(in)

5	481.5	481.5	481.5	481.5	481.5	481.5	481.5	481.5	481.5
6	802.5	802.5	802.5	802.5	802.5	802.5	802.5	802.5	802.5
7	504	504	504	504	504	504	504	504	504
8	780	780	780	780	780	780	780	780	780

	Rx$_i$								
	Base	2	3	4	5	6	7	8	9
1	9601.5	7385.7692	6401	5647.9412	5647.9412	4800.75	4800.75	4800.75	6000.938
2	11821.5	7881	6953.8235	5910.75	5373.4091	4925.625	4728.6	4546.7308	5910.75
3	24759.1667	20257.5	20257.5	17140.962	17140.962	17140.962	15916.607	13927.031	11728.03
4	34465.5	31332.273	24618.214	21540.938	19147.5	19147.5	18139.737	17232.75	21540.94
Sum	80647.6667	66856.542	58230.538	50240.59	47309.812	46014.837	43585.694	40507.262	45180.65
x_{cr}(in)	1060.37838	1110.5652	1093.5691	1093.9556	1080.1329	1109.6768	1100.6175	1089.5526	1072.873
x_{cr}(ft)	88.3648649	92.547099	91.130762	91.162964	90.011076	92.47307	91.718124	90.796053	89.40607
5	2783.67188	2969.25	2969.25	3299.1667	3563.1	3872.9348	4948.75	4241.7857	258.1957
6	4639.45313	4948.75	4948.75	5498.6111	5938.5	6454.8913	8247.9167	7069.6429	430.3261
7	3729.6	1942.5	1277.2603	991.91489	825.13274	734.17323	647.5	652.02797	504
8	5772	3006.25	1976.7123	1535.1064	1276.9912	1136.2205	1002.0833	1009.0909	780
Sum	16924.725	12866.75	11171.973	11324.799	11603.724	12198.22	14846.25	12972.547	1972.522
y_{cr}(in)	642	642	642	642	642	642	642	642	642
y_{cr}(ft)	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5

Torsional Moment due to eccentricity

E-W	Base	2	3	4	5	6	7	8	9
Force	54123.9625	25135.538	29647.617	25643.658	25959.535	13491.152	11816.95	8472.6422	2574.441
5% ecc	61338.1151	55750.422	49661.172	43194.758	36432.969	29424.753	22030.395	13415.978	3322.056

N-S	Base	2	3	4	5	6	7	8	9
Force	-11165.643	-10180.178	-9081.8737	-7898.7164	-6649.1066	-5344.0565	-3958.6331	-2335.9778	-740.8582
5% ecc	25308.7913	23075.07	20585.58	17903.757	15071.308	12113.195	8972.9017	5294.883	1679.279

Eccentric Shear Calculation

	Base	2	3	4	5	6	7	8	9
	x	x	x	x	x	x	x	x	x
1	541.38	591.57	574.57	574.96	561.13	590.68	581.62	570.55	553.87
2	421.38	471.57	454.57	454.96	441.13	470.68	461.62	450.55	433.87
3	-144.12	-93.93	-110.93	-110.54	-124.37	-94.82	-103.88	-114.95	-131.63
4	-802.62	-752.43	-769.43	-769.04	-782.87	-753.32	-762.38	-773.45	-790.13
	y	y	y	y	y	y	y	y	y
5	160.50	160.50	160.50	160.50	160.50	160.50	160.50	160.50	160.50
6	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50	-160.50
7	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00	138.00
8	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00	-138.00

	Base	2	3	4	5	6	7	8	9
	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
1	10016	8418	7086	6257	6106	5464	5380	5278	6404
2	7796	5816	4947	4208	3710	3628	3416	3206	4013
3	-2963	-1580	-1866	-1573	-1770	-1349	-1373	-1329	-1282
4	-14849	-12655	-10167	-8892	-8046	-7742	-7423	-7154	-9136
	Ry	Ry	Ry	Ry	Ry	Ry	Ry	Ry	Ry
5	928	990	990	1100	1188	1291	1650	1414	86
6	-928	-990	-990	-1100	-1188	-1291	-1650	-1414	-86
7	1021	532	350	272	226	201	177	179	138
8	-1021	-532	-350	-272	-226	-201	-177	-179	-138

	Base	2	3	4	5	6	7	8	9
	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2	Rx^2
1	5422175	4980049	4071600	3597422	3426528	3227317	3129080	3011155	3547087
2	3284855	2742609	2248654	1914607	1636394	1707679	1576871	1444407	1741272
3	426960	148399	206959	173901	220110	127955	142603	152774	168698
4	11917727	9521751	7823172	6838402	6299053	5832596	5659316	5533543	7218480
Sum	21051718	17392808	14350385	12524332	11582086	10895546	10507870	10141879	12675537
	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2	Ry^2
5	148926	158855	158855	176505	190626	207202	264758	226936	13813
6	148926	158855	158855	176505	190626	207202	264758	226936	13813
7	140926	73399	48262	37480	31178	27741	24466	24637	19044
8	140926	73399	48262	37480	31178	27741	24466	24637	19044
Sum	579704	464507	414234	427971	443608	469887	578449	503146	65715

Both counterclockwise and clockwise moment will be considered due to 5% eccentricity

Eccentric Shear for E-W (kip)

For counterclockwise moment; positive values mean resistance in the positive y direction, otherwise its the negative y direction; and vice versa for negative values

	Base	2	3	4	5	6	7	8	9
1	29.1820	26.9842	24.5231	21.5791	19.2086	14.7556	11.2794	6.9814	1.6784
2	22.7136	18.6424	17.1189	14.5140	11.6688	9.7982	7.1618	4.2408	1.0518
3	-8.6318	-5.0639	-6.4563	-5.4255	-5.5673	-3.6442	-2.8780	-1.7581	-0.3359
4	-43.2639	-40.5627	-35.1857	-30.6676	-25.3102	-20.9095	-15.5632	-9.4640	-2.3944

For counterclockwise moment; positive values mean resistance in the negative x direction, otherwise its the positive x direction; and vice versa for negative values

5	98.1795	118.7904	118.6579	110.9940	97.5443	80.8423	62.8249	37.7013	4.3508
6	-98.1795	-118.7904	-118.6579	-110.9940	-97.5443	-80.8423	-62.8249	-37.7013	-4.3508
7	108.0525	63.8359	41.9275	27.4119	18.5553	12.5883	6.7522	4.7604	6.9762
8	-108.0525	-63.8359	-41.9275	-27.4119	-18.5553	-12.5883	-6.7522	-4.7604	-6.9762

Direct Shear for E-W (kip)

positive value means that its resisting in the negative y direction

	Base	2	3	4	5	6	7	8	9
1	128.29	113.32	98.90	88.01	77.83	56.44	44.25	28.70	7.84
2	128.29	98.21	87.27	74.81	60.14	47.03	35.40	22.08	6.27
3	142.54	133.92	134.87	115.09	101.78	86.83	63.21	35.88	6.60
4	128.29	133.92	105.97	93.51	73.51	62.71	46.58	28.70	7.84
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0

Eccentric Shear for N-S (kip)

For counterclockwise moment; positive values mean resistance in the positive y direction, otherwise its the negative y direction; and vice versa for negative values

	Base	2	3	4	5	6	7	8	9
1	12.0408	11.1687	10.1653	8.9443	7.9461	6.0744	4.5941	2.7553	0.8484
2	9.3719	7.7161	7.0961	6.0159	4.8271	4.0336	2.9170	1.6737	0.5317
3	-3.5616	-2.0959	-2.6763	-2.2488	-2.3030	-1.5002	-1.1722	-0.6939	-0.1698
4	-17.8512	-16.7889	-14.5852	-12.7114	-10.4701	-8.6078	-6.3388	-3.7352	-1.2103

For counterclockwise moment; positive values mean resistance in the negative x direction, otherwise its the positive x direction; and vice versa for negative values

5	40.5100	49.1673	49.1861	46.0058	40.3514	33.2801	25.5884	14.8796	2.1993
6	-40.5100	-49.1673	-49.1861	-46.0058	-40.3514	-33.2801	-25.5884	-14.8796	-2.1993
7	44.5837	26.4217	17.3798	11.3619	7.6758	5.1822	2.7501	1.8788	3.5265
8	-44.5837	-26.4217	-17.3798	-11.3619	-7.6758	-5.1822	-2.7501	-1.8788	-3.5265

Direct Shear for N-S (kip)

positive value means that its resisting in the negative x direction

	Base	2	3	4	5	6	7	8	9
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	68.02	87.01	89.40	85.22	75.62	62.84	48.87	28.29	3.59
6	68.02	87.01	89.40	85.22	75.62	62.84	48.87	28.29	3.59
7	87.06	54.38	36.74	24.48	16.73	11.38	6.11	4.15	6.70
8	87.06	54.38	36.74	24.48	16.73	11.38	6.11	4.15	6.70

For counterclockwise moments

Total Shear for E-W direction

positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	128.2896	113.3175	98.9038	88.0074	77.8330	56.4382	44.2463	28.7012	7.8429
2	128.2896	98.2085	87.2681	74.8063	60.1437	47.0319	35.3970	22.0778	6.2743
3	151.1758	138.9846	141.3252	120.5121	107.3488	90.4723	66.0870	37.6346	6.9404
4	171.5535	174.4833	141.1541	124.1754	98.8191	83.6187	62.1382	38.1652	10.2372
5	98.1795	118.7904	118.6579	110.9940	97.5443	80.8423	62.8249	37.7013	4.3508
6	-98.1795	-118.7904	-118.6579	-110.9940	-97.5443	-80.8423	-62.8249	-37.7013	-4.3508
7	108.0525	63.8359	41.9275	27.4119	18.5553	12.5883	6.7522	4.7604	6.9762
8	-108.0525	-63.8359	-41.9275	-27.4119	-18.5553	-12.5883	-6.7522	-4.7604	-6.9762

For clockwise moments
Total Shear for E-W direction
positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	157.471645	140.30169	123.42699	109.58649	97.041603	71.193795	55.525697	35.682557	9.521291
2	151.00326	116.85085	104.38701	89.320274	71.812466	56.830087	42.558812	26.318628	7.326119
3	142.544015	133.92068	134.86888	115.08657	101.78158	86.828065	63.208968	35.876469	6.604517
4	128.289613	133.92068	105.9684	93.50784	73.508921	62.709158	46.575029	28.701175	7.842864
5	-98.179507	-118.79035	-118.65788	-110.99398	-97.544276	-80.842316	-62.824877	-37.701271	-4.350814
6	98.1795072	118.79035	118.65788	110.99398	97.544276	80.842316	62.824877	37.701271	4.350814
7	-108.05251	-63.835938	-41.927507	-27.411916	-18.555275	-12.588295	-6.7522065	-4.7603984	-6.976248
8	108.052512	63.835938	41.927507	27.411916	18.555275	12.588295	6.7522065	4.7603984	6.976248

For counterclockwise moments
Total Shear for N-S direction
positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	-12.0408	-11.1687	-10.1653	-8.9443	-7.9461	-6.0744	-4.5941	-2.7553	-0.8484
2	-9.3719	-7.7161	-7.0961	-6.0159	-4.8271	-4.0336	-2.9170	-1.6737	-0.5317
3	3.5616	2.0959	2.6763	2.2488	2.3030	1.5002	1.1722	0.6939	0.1698
4	17.8512	16.7889	14.5852	12.7114	10.4701	8.6078	6.3388	3.7352	1.2103
5	108.5268	136.1773	138.5843	131.2307	115.9702	96.1222	74.4604	43.1693	5.7910
6	68.0168	87.0101	89.3982	85.2249	75.6189	62.8421	48.8720	28.2897	3.5917
7	131.6452	80.8030	54.1188	35.8414	24.4056	16.5630	8.8592	6.0332	10.2245
8	87.0615	54.3813	36.7390	24.4795	16.7298	11.3809	6.1090	4.1544	6.6980

For clockwise moments
Total Shear for N-S direction
positive values are for negative x and y directions

	Base	2	3	4	5	6	7	8	9
1	12.0408	11.1687	10.1653	8.9443	7.9461	6.0744	4.5941	2.7553	0.8484
2	9.3719	7.7161	7.0961	6.0159	4.8271	4.0336	2.9170	1.6737	0.5317
3	-3.5616	-2.0959	-2.6763	-2.2488	-2.3030	-1.5002	-1.1722	-0.6939	-0.1698
4	-17.8512	-16.7889	-14.5852	-12.7114	-10.4701	-8.6078	-6.3388	-3.7352	-1.2103
5	68.0168325	87.010068	89.398164	85.224901	75.618865	62.842145	48.872014	28.289704	3.591687
6	108.526794	136.17733	138.5843	131.2307	115.97023	96.122245	74.460364	43.169262	5.790996
7	87.0615456	54.381292	36.738971	24.479493	16.729837	11.380861	6.1090017	4.1544321	6.698011
8	131.645219	80.802953	54.118788	35.841434	24.40564	16.563044	8.8591515	6.0332181	10.22446

Max Story Shears to check in etabs

	Base	2	3	4	5	6	7	8	9
1	157.471645	140.30169	123.42699	109.58649	97.041603	71.193795	55.525697	35.682557	9.521291
2	151.00326	116.85085	104.38701	89.320274	71.812466	56.830087	42.558812	26.318628	7.326119
3	151.1758	138.9846	141.3252	120.5121	107.3488	90.4723	66.0870	37.6346	6.9404
4	171.5535	174.4833	141.1541	124.1754	98.8191	83.6187	62.1382	38.1652	10.2372
5	108.5268	136.1773	138.5843	131.2307	115.9702	96.1222	74.4604	43.1693	5.7910
6	108.526794	136.17733	138.5843	131.2307	115.97023	96.122245	74.460364	43.169262	5.790996
7	131.6452	80.8030	54.1188	35.8414	24.4056	16.5630	8.8592	6.0332	10.2245
8	131.645219	80.802953	54.118788	35.841434	24.40564	16.563044	8.8591515	6.0332181	10.22446

Max wind forces to add in etabs

	2	3	4	5	6	7	8	9	10
1	17.17	16.87	13.84	12.54	25.85	15.67	19.84	26.16	9.52
2	34.15	12.46	15.07	17.51	14.98	14.27	16.24	18.99	7.33
3	12.19	-2.34	20.81	13.16	16.88	24.39	28.45	30.69	6.94
4	-2.93	33.33	16.98	25.36	15.20	21.48	23.97	27.93	10.24
5	-27.65	-2.41	7.35	15.26	19.85	21.66	31.29	37.38	5.79
6	-27.65	-2.41	7.35	15.26	19.85	21.66	31.29	37.38	5.79
7	50.84	26.68	18.28	11.44	7.84	7.70	2.83	-4.19	10.22
8	50.84	26.68	18.28	11.44	7.84	7.70	2.83	-4.19	10.22