Executive Summary

This is a report to investigate the lateral system of the Earth and Engineering Sciences Building, which is located at the Pennsylvania State University campus in University Park. Its location will be a critical component of the lateral analysis performed in this report. In addition, several issues will be addressed in order to accurately evaluate the application of the system.

The framing system consists of a few main elements. This building is mostly steel framed. However, concrete is used for footings, column piers, load bearing walls, and shear walls. The shear walls, contrary to what was initially believed, are the main lateral resistant element. In technical report 1 the lateral system was evaluated as a moment resisting steel frame, but after discussion with the structural engineer it was determined that the shear walls were the main component in lateral resistance. This was mentioned in report 1, but will now be evaluated in depth.

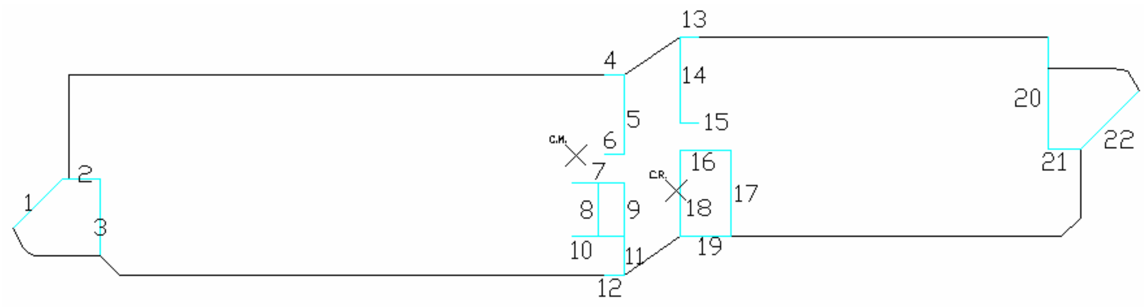
In this report several issues will be discussed. Load cases will be determined in accordance to the codes listed in this report. Drift and story drift calculations will be made in order to determine the relative strength of the lateral system. Overturning moments and the impact they will have on the foundation will be investigated. Forces in the shear walls will be calculated using seismic loading as the critical case. Finally, a spot check of these walls will be performed in order to validate the size and reinforcement of these walls.

After investigation of the lateral system, it has been determined that the shear walls are adequate to resist the loading on the building. Drift on the shear walls is very small and is much less than the allowable drift. The amount of concrete in the walls is sufficient to withstand the lateral loads and does not require shear reinforcement beyond the minimum. It was also determined that the shear walls can substantially resist overturning moment.

Lateral System:

The lateral resisting elements in this system are concrete shear walls. It was originally believed that a steel moment resisting frame was the primary lateral element. However, after discussing this matter with a member of L. Robert Kimball and Associates it has been determined that the steel frame does not provide the strength needed to resist lateral forces and acts mostly against gravitational loads. The steel frame does aid in the transfer of lateral loads to the shear walls. The shear walls are 12" thick concrete walls, which are reinforced by #5 steel rebar at 12" spacing each way on each face. The shear walls are also load bearing as will be discussed in the load path section of this report. There are a total of 22 shear wall elements which can be seen in the plan below. The number of walls and the orientation provides a rather simplistic geometry when evaluating the distribution of lateral forces, with the exception of walls 1 and 22. To simplify the analysis further these walls will be considered to act in the critical North-South direction. This assumption will not be recommended in all cases, but due to the smaller size of this building it will later be shown to be a small consideration.

Plan of existing shear walls:



Frame: The frame of the EES Building is a steel frame consisting of A36 steel. The steel columns are encased in concrete and are mostly gravity bearing elements. These columns rest on concrete piers at the foundation of the building where load is then transferred to the soil. Steel beams span between most columns and some frame into shear walls. The steel beam acts compositely with concrete on metal decking. A typical section of the frame can be seen in appendix 8. (This is similar to the frame found in Technical Assignment 1)

Floor System: It was briefly mentioned in the previous section that the floor system was composed of concrete on metal decking that acted compositely with steel beams. The depth of the concrete and decking is 6 ½", which makes it a rather heavy floor system. This is important when considering lateral loads in a building as the weight directly impacts the seismic loading seen by a building. In most cases the floor system in this building ties directly to shear walls and aids in the transfer of lateral loads.

Floor System: The foundation of the EES Building is composed primarily of slab on grade and concrete footings. The concrete footings range in size and perform as a load transfer point between concrete piers and the soil underneath. Strip footings are also present under the load bearing walls and also aid in the transfer of gravity loads from the structure to the underlying soil.

Plan: An additional plan view of a typical floor can be seen in appendix D. (This is similar to the plan found in Technical Assignment 1)

Load Path: To follow the load path through the building we must start at the exterior walls. These walls are reinforced concrete walls and provide sum load bearing strength. Encased in these exterior walls are steel columns. As lateral loads such as wind and seismic act on the exterior walls the force is transferred into the steel columns. The steel columns transfer loading into the flooring system. Composed of concrete on metal decking acting compositely with steel beams the loads transferred form the steel columns are often amplified by the mere weight of this flooring system. It will be seen later that the weight of the flooring system causes the lateral loading to be controlled by seismic forces. After the load is transferred to the floor system it then enters the shear walls. This is done by beams that rest on the shear wall and are connected directly to it. Also in several locations the metal decking is attached directly to the shear wall by steel shear studs. As a result the shear wall becomes the primary lateral resisting element in the structure.

Loads: (Loads are identical to those found in technical report 1, with a small correction to snow load)

1. **Dead**
   - **1st – 4th Floor:** Metal Deck/Steel and Topping – 46 psf

Metal Deck/Steel and Topping	– 46 psf
Spray-on Fireproofing	– 4 psf
Mech/Elec	– 10 psf
Sprinklers	– 5 psf
Ceiling	– 5 psf
	70 psf

- **Roof:**

Metal Deck	– 2 psf
Roofing	– 2 psf
Insulation	– 2 psf
Spray-on Fireproofing	– 4 psf
Mech/Elec	– 10 psf
Sprinklers	– 5 psf
Ceiling	– 5 psf
	30 psf

2. **Live (See Appendix C for diagrams)**
   - 150 psf for Mechanical Areas
   - 125 psf for Laboratory Areas
   - 100 psf for Stairs and exits
   - 80 psf for Corridors above first floor in schools
   - 60 psf for Assembly areas and theatres with fixed seating

3. **Snow (ASCE7-02)**
   - $S = .7C_eC_tC_sp_gI$
     1. $C_e = .9$ from Table 7-2
     2. $C_t = 1$ from Table 7-3
     3. $C_s = 1$ for flat roof from Fig. 7-2
     4. $P_g = 40$ psf from Fig. 7-1
     5. $I_s = 1$ for Cat. II from Table 7- 4

   $S = 25.2$ psf

4. Wind (ASCE7-02)

(See Appendix A for spreadsheet used to determine wind pressure factors)

Pressures:

N-S Direction

Leeward = $q_h C_p G$ = - 8.38 psf

Windward = $q_z C_p G$ = see table 1

E-W Direction

Leeward = $q_h C_p G$ = - 3.51 psf

Windward = $q_z C_p G$ = see table 1

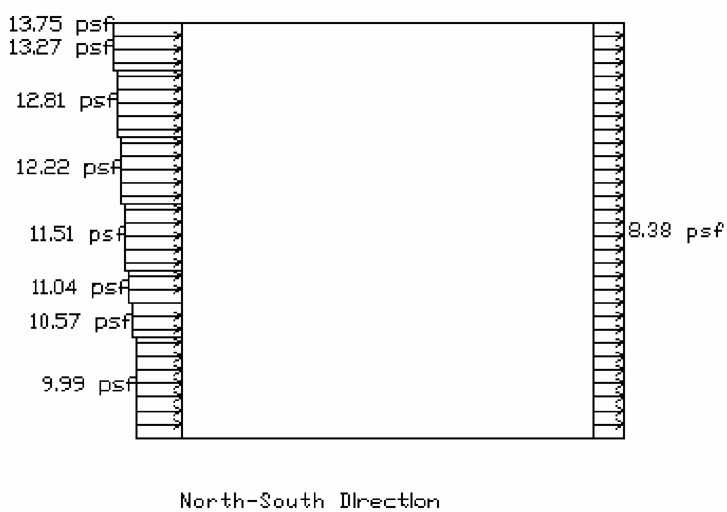
Table 1

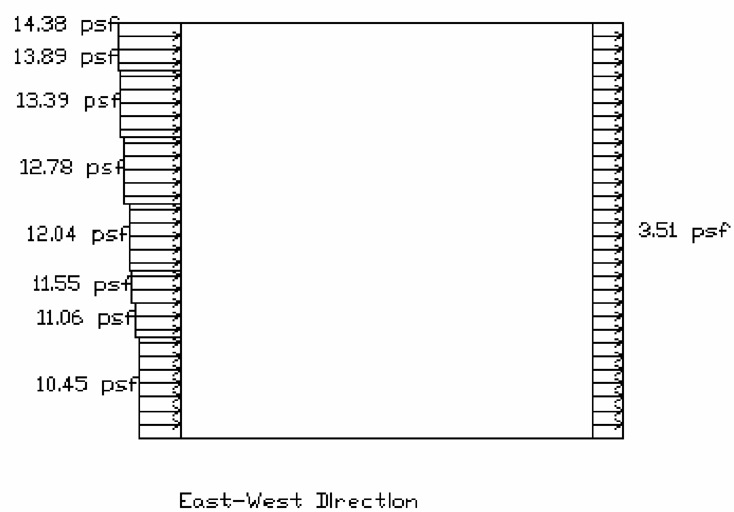
Pressures		
Z (ft)	N-S (psf)	E-W (psf)
0-15	9.99	10.45
20	10.57	11.06
25	11.04	11.55
30	11.51	12.04
40	12.22	12.78
50	12.81	13.39
60	13.27	13.89
70	13.75	14.38

Table 2

	Forces (kips)					
Story	N-S windward	N-S leeward	N-S total	E-W windward	E-W leeward	E-W total
1	50.4	41.16	91.5	10.74	3.51	14.25
2	53.8	37.73	91.5	11.46	3.22	14.68
3	58.1	37.73	95.83	12.4	3.22	15.62
4	30.1	18.9	49	6.4	1.61	8.01

From Table 2 it can be seen that the North-South direction provides the greatest story forces. These forces yield a base shear of 327.83 kips and an overturning moment of 12,024 ft-k.



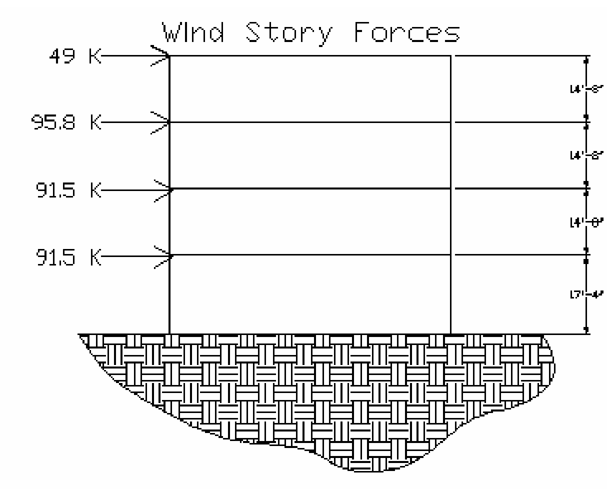


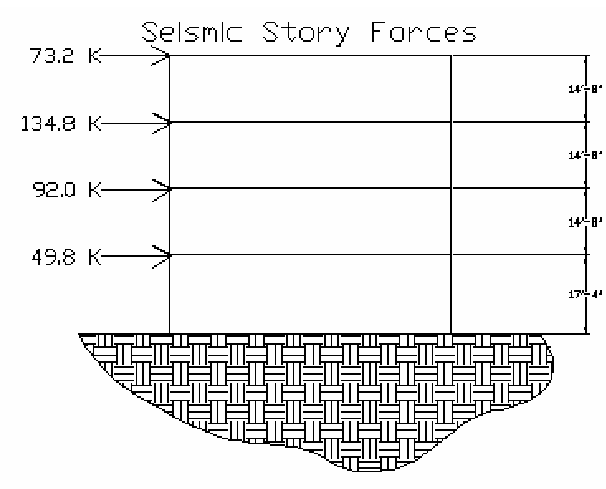
5. Seismic (See Appendix B for spreadsheet used to determine factors)

Table 3 will summarize the results of the seismic load analysis. The story shears, base shear, and overturning moment are all presented. The base shear is 349.7 kips and the overturning moment has a magnitude of 14,630 ft-kips.

Table 3

Story	w_x	h_x	$w_x h_x^k$	C_{vx}	F_x (kips)	M_x (ft-kips)
4	618.16	62.00	38,326	0.20920	73.2	4,536
3	1,513.17	46.66	70,604	0.38538	134.8	6,288
2	1,505.63	32.00	48,180	0.26298	92.0	2,943
1	1,505.74	17.33	26,095	0.14243	49.8	863
Σ	5,142.70		183,205	1	349.7	14,630





From the loading above it is clear that seismic forces are the critical factor in an investigation of this lateral system. The base shear and overturning moment are significantly larger than that of the wind loading forces.

Load Combinations:

1.2DL + 1.6LL
.9DL + E
.9DL + 1.6W
1.2DL + E +.5LL
1.2DL + 1.6W + .5LL

Material Strengths:

- Steel
  - All steel A36 – Fy = 36 ksi
    Unless otherwise noted
- Concrete
  - All concrete f'c = 4 ksi
  - Minimum 28 day design compressive strength

Codes:

ASCE7-02
IBC 2003
BOCA 1993

Lateral Force Distribution:

The following procedure will provide a way to approximate how lateral loads will be distributed to all of the shear walls. Each wall was considered on a floor by floor analysis. The procedure starts by determining a classification of each shear

wall. In this case most walls were an intermediate style wall as opposed to a short or tall wall. This was found from the H/L ratio which was between .3 and 3 in most cases. From this classification a rigidity factor could be determined for each wall. Rigidities can be seen below along with H/L factors

H/L				
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor
1	0.788	0.667	0.667	0.667
2	1.444	1.222	1.222	1.222
3	0.722	0.611	0.611	0.611
4	2.889	2.445	2.445	2.445
5	0.693	0.587	0.587	0.587
6	2.889	2.445	2.445	2.445
7	1.083	0.917	0.917	0.917
8	1.019	0.863	0.863	0.863
9	1.019	0.863	0.863	0.863
10	1.083	0.917	0.917	0.917
11	1.444	1.222	1.222	1.222
12	2.889	2.445	2.445	2.445
13	2.889	2.445	2.445	2.445
14	0.642	0.543	0.543	0.543
15	2.889	2.445	2.445	2.445
16	1.083	0.917	0.917	0.917
17	0.642	0.543	0.543	0.543
18	0.642	0.543	0.543	0.543
19	1.083	0.917	0.917	0.917
20	0.491	0.415	0.415	0.415
21	1.733	1.467	1.467	1.467
22	0.665	0.564	0.564	0.564

K - Rigidities				
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor
1	4.18	4.827	4.827	4.827
2	1.079	1.371	1.371	1.371
3	4.933	5.615	5.615	5.615
4	0.166	0.225	0.225	0.225
5	5.317	6.014	6.014	6.014
6	0.166	0.225	0.225	0.225
7	2.141	2.605	2.605	2.605
8	2.451	2.953	2.953	2.953
9	2.451	2.953	2.953	2.953
10	2.141	2.605	2.605	2.605
11	1.079	1.371	1.371	1.371
12	0.166	0.225	0.225	0.225
13	0.166	0.225	0.225	0.225
14	6.098	6.818	6.818	6.818
15	0.166	0.225	0.225	0.225
16	2.141	2.605	2.605	2.605
17	6.098	6.818	6.818	6.818
18	6.098	6.818	6.818	6.818
19	2.141	2.605	2.605	2.605
20	9.442	10.171	10.171	10.171
21	0.676	0.878	0.878	0.878
22	5.705	6.415	6.415	6.415

After rigidities for each wall were computed it was necessary to find the center of rigidity. Components used to determine the center of rigidity and the coordinates for the C.O.R. can be found below.

Components for Center of Rigidity				
Wall	X	Y		
1	0		4.18	4.827
2		30.167	1.079	1.371
3	27.5		4.933	5.615
4		62.66	0.166	0.225
5	191.5		5.317	6.014
6		37.66	0.166	0.225
7		29	2.141	2.605
8	183.5		2.451	2.953
9	191.5		2.451	2.953
10		12	2.141	2.605
11	191.5		1.079	1.371
12		0	0.166	0.225
13		75	0.166	0.225
14	209		6.098	6.818
15		48	0.166	0.225
16		39	2.141	2.605
17	225		6.098	6.818
18	209		6.098	6.818
19		12	2.141	2.605
20	324.5		9.442	10.171
21		39.333	0.676	0.878
22	353		5.705	6.415
			53.85	60.772
			11.149	13.793

	Center of Rigidity				
	1st Floor	2nd Floor	3rd Floor	4th Floor	
X_{cr}	209.436	207.74	207.74	207.74	
Y_{cr}	26.296	26.516	26.52	26.52	

Eccentricities	
E_x (ft)	-31.24
E_y (ft)	11

Torsional Moment for Each Floor				
	1st Floor	2nd Floor	3rd Floor	4th Floor
M_t (ft-kips)	-1555.75	-2874.08	-4211.15	-2286.77

Based on the center of rigidity and the center of mass which was determined by the buildings geometry a set of eccentricities were determined. Using the eccentricities and the shear force applied at each story a torsional moment could be calculated. These properties can be found above.

The remaining step to the procedure is to distribute the forces. Two components to the total force exist, a direct force and a torsional force due to the torsional moment at each floor. Only the North-South walls will receive a direct force component. All walls will receive a torsional component based on their rigidness and distance from the center of rigidity. A summary of the forces is provided on the next page. As can be seen by this summary there are not any instances of extreme forces present in any one wall. This is mostly due to the presence of multiple walls acting in each direction

			1st	2nd - 4th
Wall	d_i	d_i^2	Kd_i^2	Kd_i^2
1	-207.74	43155.93	180391.8	208306.2
2	3.651	13.329	14.38	18.268
3	-180.24	32486.48	160241.8	182427.4
4	36.144	1306.402	216.831	293.376
5	-16.24	263.739	1402.241	1586.202
6	11.144	124.193	20.613	27.89
7	2.484	6.171	13.213	16.078
8	-24.24	587.58	1439.981	1734.945
9	-16.24	263.739	646.345	778.742
10	-14.516	210.709	451.158	548.965
11	-16.24	263.739	284.548	361.469
12	-26.516	703.088	116.696	157.891
13	48.484	2350.717	390.163	527.896
14	1.26	1.587	9.68	10.823
15	21.484	461.57	76.61	103.654
16	12.484	155.855	333.708	406.053
17	17.26	297.906	1816.542	2030.99
18	1.26	1.587	9.68	10.823
19	-14.516	210.709	451.158	548.965
20	116.76	13632.89	128716.3	138664.3
21	12.817	164.28	111.052	144.297
22	145.26	21100.45	120386.3	135362.6
		J (ft^2) =	597540.8	674067.8

F_{direct} (kips)				
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor
1	3.866	7.307	10.707	5.814
3	4.562	8.501	12.456	6.764
5	4.917	9.105	13.341	7.244
8	2.266	4.47	6.549	3.557
9	2.266	4.47	6.549	3.557
11	0.998	2.075	3.04	1.651
14	5.639	10.321	15.122	8.212
17	5.639	10.321	15.122	8.212
18	5.639	10.321	15.122	8.212
20	8.732	15.398	22.561	12.251
22	5.276	9.712	14.23	7.727

$F_{torsion}$ (kips)				
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor
1	2.261	4.275	6.264	3.402
2	-0.01	-0.021	-0.031	-0.017
3	2.315	4.316	6.323	3.434
4	-0.016	-0.035	-0.051	-0.028
5	0.225	0.416	0.61	0.331
6	-0.005	-0.011	-0.016	-0.008
7	-0.014	-0.028	-0.04	-0.022
8	0.155	0.305	0.447	0.243
9	0.104	0.204	0.3	0.163
10	0.081	0.161	0.236	0.128
11	0.046	0.095	0.139	0.076
12	0.011	0.025	0.037	0.02
13	-0.021	-0.046	-0.068	-0.037
14	-0.02	-0.037	-0.054	-0.029
15	-0.009	-0.021	-0.03	-0.016
16	-0.07	-0.139	-0.203	-0.11
17	-0.274	-0.502	-0.735	-0.399
18	-0.02	-0.037	-0.054	-0.029
19	0.081	0.161	0.236	0.128
20	-2.87	-5.064	-7.419	-4.029
21	-0.023	-0.048	-0.07	-0.038
22	-2.158	-3.973	-5.822	-3.161

F_{total} (kips)				
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor
1	6.126	11.583	16.971	9.216
2	0.01	0.021	0.031	0.017
3	6.876	12.817	18.779	10.198
4	0.016	0.035	0.051	0.028
5	5.142	9.521	13.951	7.576
6	0.005	0.011	0.016	0.008
7	0.014	0.028	0.04	0.022
8	2.421	4.775	6.997	3.799
9	2.37	4.674	6.849	3.719
10	0.081	0.161	0.236	0.128
11	1.043	2.17	3.179	1.726
12	0.011	0.025	0.037	0.02
13	0.021	0.046	0.068	0.037
14	5.639	10.321	15.122	8.212
15	0.009	0.021	0.03	0.016
16	0.07	0.139	0.203	0.11
17	5.639	10.321	15.122	8.212
18	5.639	10.321	15.122	8.212
19	0.081	0.161	0.236	0.128
20	8.732	15.398	22.561	12.251
21	0.023	0.048	0.07	0.038
22	5.276	9.712	14.23	7.727

The above distribution method provided an approximation of how the lateral loads seen be the total system will be transferred to each shear wall. The main loading is seen in the North-South walls which were said to be the critical design elements. This may explain why these are the longest of the shear walls to provide much more resistance to loads seen in the North-South direction which is the narrow part of the building. The fact that there are 22 walls is the main reason that the forces are small. When this many walls exist a base shear of around 350 kips can be easily distributed without need for massive walls.

Overturning Moment: Overturning Moment Check for shear wall 1

M_{OT} = (9.22 x 62) + (16. 97 x 47.3) + (11.58 x 32.68) + (6.92 x 17.33) = 1872.68 ft-kip
M_R = 150(1') (22') (62') (22'/2) = 2250.6 ft-kip > 1872.68 ft-kip

The self weight of the shear wall is enough to resist overturning moment; additional loads from the structure provide additional weight to provide stability. The reinforcement in the shear wall will also help to provide more strength against overturning. After investigation it does not appear that overturning moments will be a critical component in the design process. Furthermore additional considerations will not need to be taken into account when designing the strip footing that this wall will rest on as gravity loads should control.

Drift:

Drift in the Earth and Engineering Sciences Building is quite small as it should be. The building is a four story building and is quite massive in terms of weight. The number of shear walls in this building makes it quite rigid and able to significantly resist lateral forces. As a result the story drift and total drift are quite small. In this analysis is will be considered that the drift of the entire building will be equal to that of the critical shear wall. Each wall was evaluated considering two drift components: a shear and a bending component. Based on the formula, $\Delta_T = (1.5V/bE)\ [(h/l) + (h/l)^3]$, values were computed for each wall at each level and a total drift at the roof line. The most critical wall is wall 11 which has a $\Delta_{T\ @\ roof}$ = .0363, which is equivalent to a drift ratio of l/20495 for this building. An acceptable drift value would be equivalent to l/400 or in this case

(62')(12"/')/400 = 1.86 in

This is illustrated in the chart below. This value is not reached by any of the shear walls at the roof line. In conclusion this building is okay when considering drift factors.

Drift (in)					
Wall	1st Floor	2nd Floor	3rd Floor	4th Floor	Total
1	0.000244	0.000348	0.000510	0.000277	0.0345
2	N/A	N/A	N/A	N/A	N/A
3	0.000236	0.000336	0.000492	0.000267	0.0302
4	N/A	N/A	N/A	N/A	N/A
5	0.000165	0.000234	0.000434	0.000187	0.0201
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	0.000126	0.000184	0.000269	0.000146	0.0293
9	0.000120	0.000180	0.000260	0.000140	0.0287
10	N/A	N/A	N/A	N/A	N/A
11	0.000145	0.000206	0.000301	0.000160	0.0363
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	0.000160	0.000230	0.000330	0.000180	0.0177
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	0.000160	0.000230	0.000330	0.000180	0.0177
18	0.000160	0.000230	0.000330	0.000180	0.0177
19	N/A	N/A	N/A	N/A	N/A
20	0.000170	0.000230	0.000340	0.000180	0.0132
21	N/A	N/A	N/A	N/A	N/A
22	0.000160	0.000230	0.000330	0.000180	0.0184

Spot Check: Design for Shear

• Check shear strength in 1st story of wall 1
Total shear = 6.126+ 11.583 +16.971 +9.216 = 43.9 kips
Per ACI 318-02 Sect. 9.2, Vu= 1.6 x 43.9 = 70.24 kips
φVc= 300.5 kips
Since Vu < φVc/ 2 = 150.25 kips
Story 1 provides the most critical case. Other floors do not need to be considered since a minimum steel reinforcement is used at level one. Minimum steel should be continued to upper levels.
Provide minimum reinforcement.
For 12” wall, use No. 4 @ 12” each way on each face.
A summary of shear values for each wall can be found below.

Spot Check of Shear Walls		
Wall	ΦVc/2	Vu
1.000	150.270	43.896
2.000	N/A	N/A
3.000	163.933	48.670
4.000	N/A	N/A
5.000	170.763	36.189
6.000	N/A	N/A
7.000	N/A	N/A
8.000	116.119	17.992
9.000	116.119	17.613
10.000	N/A	N/A
11.000	81.966	8.119
12.000	N/A	N/A
13.000	N/A	N/A
14.000	184.424	39.294
15.000	N/A	N/A
16.000	N/A	N/A
17.000	184.424	39.294
18.000	184.424	39.294
19.000	N/A	N/A
20.000	241.320	58.942
21.000	N/A	N/A
22.000	177.590	36.945

Design for Flexure

This design will be a continuance on the design for wall 1. The reinforcement needed from shear forces was a minimum. To perform this part of the analysis the reinforcement specified in the plan will be used to determine the strength of the wall.

When evaluating moment strength, the load combination given in ACI Eq. (9-6) will usually govern: U = 1.2D + E + .5L

• Dead load and seismic moment in 1st story

Tributary floor area = 100 ft^2

Wall dead load = [0.150(12 x 264)]/144 = 3.3 kips/ft wall height

Pu= 1.2[(0.03 x 100) + (0.07 x 100 x 3) + (3.3 x 62)] + .5[(.1 x 100)] = 279.32 kips

Mu= [(9.22 x 62) + (16. 97 x 47.3) + (11.58 x 32.68) + (6.92 x 17.33)] = 1872.68 ft-kips

A_{st} = 22' x .465 = 10.23 in^2

$w = (A_{st} / l_w h) (f_y/f'_c) = .048$

$a = P_u / (l_w h\ f'_c) = .022$

$c / l_w = w + a / (2w + .85b_1) = .085$

$\varphi M_n = \varphi\ [.5\ A_{st} l_w\ f_y\ (1 + P_u / (A_{st}\ f_y))\ (1 - c / l_w)]$ = 96,993.4 in-kips = 8082.81ft-kips > 1872.68 ft-kips

#5's @ 8 provide sufficient resistance to bending. These are what are specified in the plan. The tributary area was estimated to be 100 ft^2 . This assumption was a gross estimate and was rather unconservative. However with the amount of resistance the wall passed by it can be said that the reinforcement specified is ample for safety. The amount of rebar specified was also considered part of the gravity load analysis and may have also contributed to the increased amount of reinforcement used.

In conclusion it has been shown that the lateral system for the Earth and Engineering Sciences Building located at University Park, Pennsylvania is more than sufficient to resist the loads that it will be subjected to in its use. It may be considered that few shear walls could have been used and made more massive, however the use of the shear walls found in this building were planned out quite well. All the walls were placed in locations that would not only be beneficial to lateral resistance but were needed to perform other tasks. All the shear walls were placed in locations such as elevator shafts, stairwells, and mechanical shafts.

The number of shear walls used substantially reduced the amount force each wall would see. The reduction in force leads to minuscule drift values and did not require massive amounts of reinforcement. The shear walls are the same width and consist of the same reinforcement layout as the exterior walls. This would allow for the same forms to be used and the workers to easily layout steel reinforcement without unnecessary confusion. The smaller forces also helped to minimize any effects caused by overturning moments. The reduction of overturning moments allowed less rebar to be used and reduced the amount of further considerations in foundation design. I would strongly suggest the use of this lateral system and am considering keeping it in my redesign of the Earth and Engineering Sciences Building.

APPENDIX A

Velocity Pressure		
K_{zt}	1	From Fig. 6-4
K_d	0.85	From Table 6-4
V	90	From Fig 6-1
I	1	From Table 6-1

Gust Factor Calculator			
Frequency	2.26		Rigid
C_t	0.02		
h	62		
x	0.75		
G	0.85		
z_{min}	15		
c	0.2		
l	500		
ε	0.200		
gq	3.4		
gv	3.4		
z	37.2	z_h	37.2
h	62		
L_z	512.12		
I_z	0.20		
Base	307	Q	0.813126
G	0.833		

External Pressure Coefficients					
	Windward Wall				
	C_p	0.8	From Fig. 6-6		
	Leeward Wall				
N-S	length	62.6	C_p	-0.5	From Fig. 6-6
	base	307			
	ratio l/b	0.20			
E-W	length	307	Cp	-0.2	From Fig. 6-6
	base	62.6			
	ratio l/b	4.90			

Z (ft)	K_z (Table 6-3)	q_z
0-15	0.85	14.982
20	0.9	15.863
25	0.94	16.568
30	0.98	17.273
40	1.04	18.331
50	1.09	19.212
60	1.13	19.917
70	1.17	20.622
80	1.21	21.327
90	1.24	21.856
100	1.26	22.208
120	1.31	23.090
140	1.36	23.971
160	1.39	24.500

q_h	20.105

Interpolation at max. height

Article I. APPENDIX B

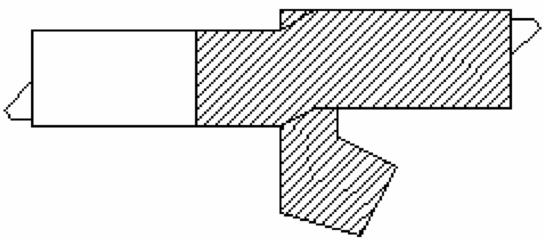
Building Properties	
B (ft)	62.5
L (ft)	307
h (ft)	62.00
# of Stories	4.00
ave. h/floor (ft)	15.50
Seismic Use group	I
Imp. (e)	1
Site Classification	C
S_s (%g)	0.17
S_1 (%g)	0.06
R	3
F_a	1.2
F_v	1.7
S_{DS}	0.204
S_{D1}	0.102
Distribution Factor	
k	1

Response	
T	0.44
C_s	0.07

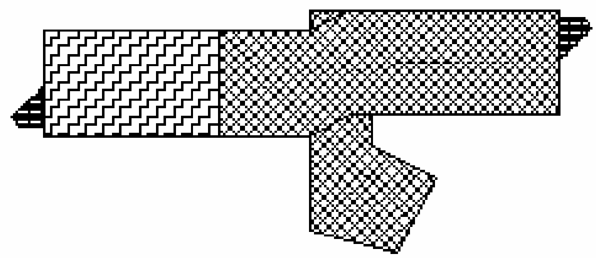
Loading (psf)	
Roof Dead	30
Snow	20
Floor Dead	70
Ex. Wall Dead	15
avg. w_{roof} (lbs)	738.3
avg. w_{floors} (lbs)	1,514.9
W_{total} (lbs)	5,142.7
V (lbs)	349.7

APPENDIX C
Drawings not to scale
Live Loads

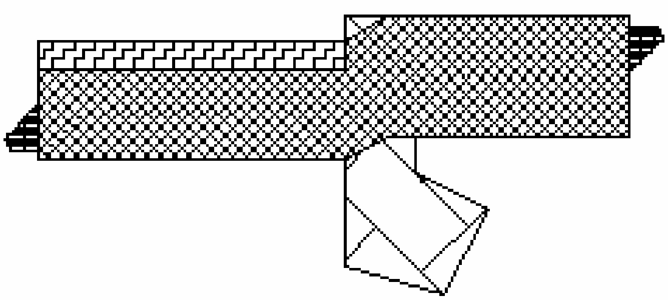
Basement



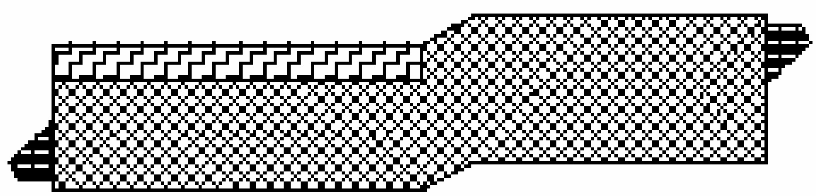
1st Floor

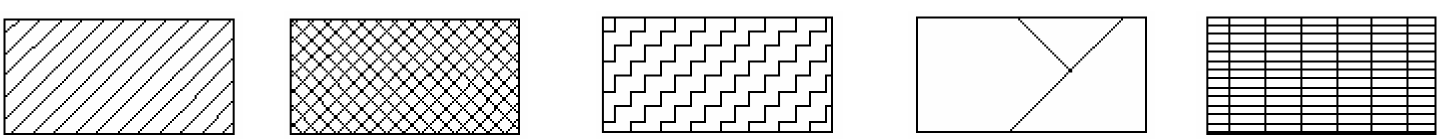


2nd Floor



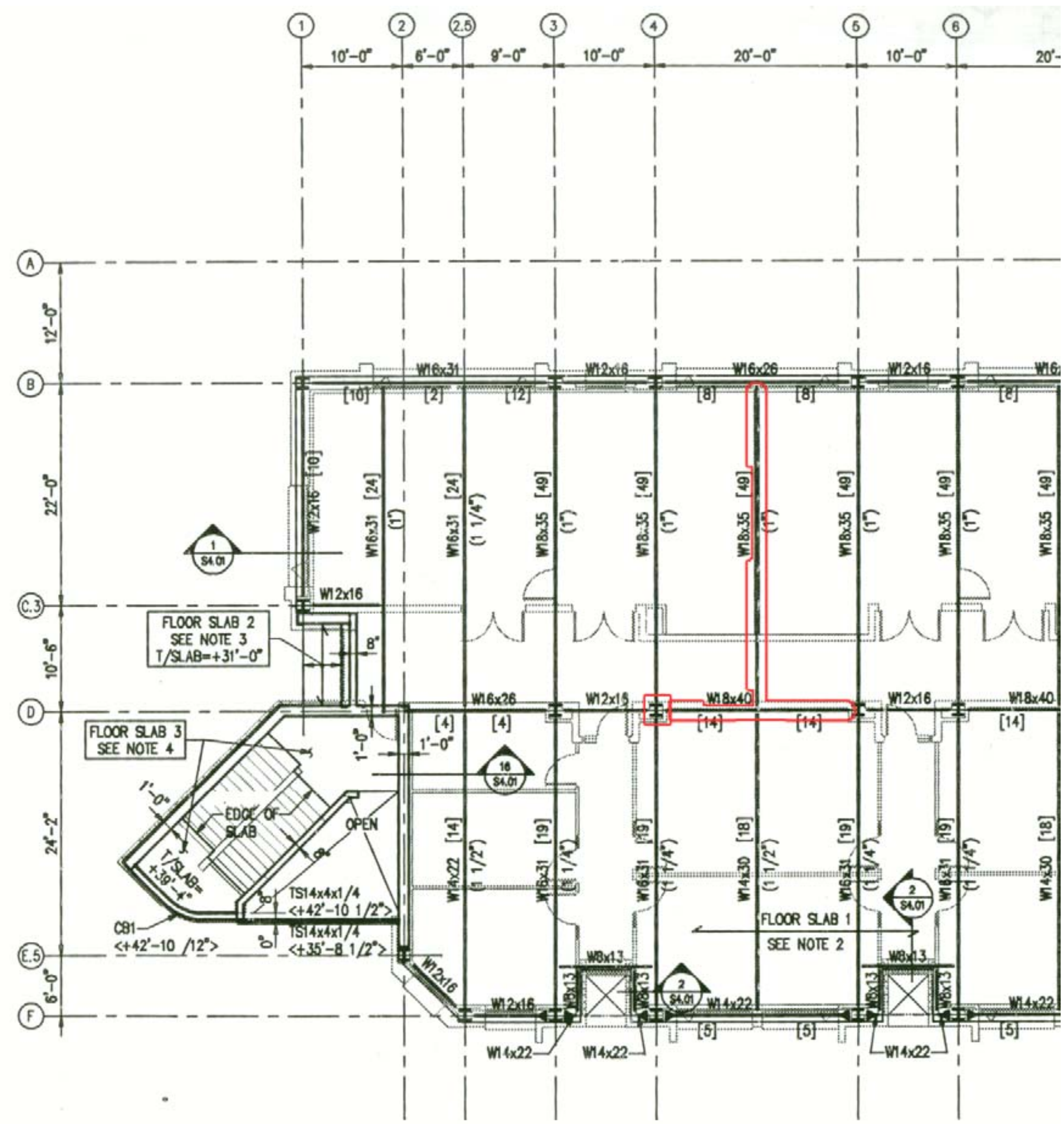
3rd – 4th Floor





150 psf | 80 psf | 125 psf | 60 psf | 100 psf

APPENDIX D
Plan of 3rd Floor West Wing (spot check elements highlighted)



THIRD FLOOR FRAMING PLAN – WEST WING

APPENDIX E
Section Through the west wing