

TECHNICAL REPORT 1

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CityFlatsHotel – Holland, Michigan

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Executive Summary

The following technical report describes the existing conditions, as well as, structural components of the CityFlatsHotel in order to comprehend the structural design of the building. Included in this report is a general summary of the primary structural concepts, calculations, diagrams, and detailed descriptions of gravity and lateral loads. This information is presented to assist in better understanding the building's structural systems. Such an analysis includes dead, live, snow, wind and seismic loading. Accompanied with the calculations are the design codes used in the original design plus the description of the structural materials. All calculations as well as building plans are provided in an Appendix at the end of the report.

CityFlatsHotel is a 5-story eco-boutique hotel located in Holland, Michigan. This unique hotel is just outside of downtown Holland at the intersection of 7th Street and College Avenue. The hotel has 56 guestrooms, a restaurant, fitness center, cinema room, and bar/lounge, to name a few features. The overall building is approximately 65,000 square feet and reaches a building height of about 65 feet. The typical floor system is 10" precast planking, while the ground floor is reinforced concrete slab on grade. The typical floor-to-floor height is 12'-0" except for the ground floor and lobby space which extends to 14'-0". The foundation system is a standard slab on grade supported by concrete footers that sit on top of compacted soil. The gravity system is an integrated system that consists of concrete masonry walls as well as steel beams and columns. The lateral resisting system is made up of reinforced masonry walls and lateral bracing on floors three to five, plus steel moment connection on the southeast corner of the building.

To get a full understanding of the structural system, an analysis of gravity, snow, wind and seismic loads were completed according to ASCE 7-05. The wind load was found to be consistent coming from both the North/South and East/West directions. Seismic loads, which were calculated using the Equivalent Lateral Force Method, were found to have similar shear effects as the wind loads. The difference can be the result of various members being controlled by different conditions, with further analysis the controlling condition can be determined.

Spot checks were performed for various structural elements in order to validate the member sizes used in the structure of CityFlatsHotel. All structural members are adequately designed with any differences being the result of this investigation taking into account only the gravity loads and ignoring the lateral forces that are in contact with the building.

Introduction: CityFlatsHotel

CityFlatsHotel is the latest eco-boutique hotel located at 61 East 7th Street in Holland Michigan. This environmentally friendly hotel has been awarded LEED Gold and is only the third eco-boutique hotel to achieve such status in the United States and is the first of its kind to earn such recognition in the Midwest. Located on the outskirts of downtown Holland, which was named the second happiest place in America in 2009, the 56-guest room hotel is a unique place to stay. Not only are the hotel rooms decorated in a variety of ways, so that no two rooms are alike, this 5-story hotel offers many additional features to keep visitors satisfied. Accommodations include guest rooms, junior suites, master suites and more. Coupled with being located close to top of the line shopping, fine dining and extravagant art venues CityFlatsHotel is the place to stay when visiting Holland and its surrounding unique attractions.

The ground floor houses the main lobby for the hotel, a fitness suite and the CitySen Lounge. Also available is office space, high-tech conference rooms, and a digital theater for those who may want to conduct business meetings or private get-togethers. The remaining floors of the building are occupied by the various hotel rooms, with the top floor mostly reserved for CityVu Bistro restaurant and City Bru bar. The views from the restaurant of downtown Holland and Lake Macatawa are spectacular, which go well with the diverse fresh entrees served at CityVu Bistro.

The exterior of CityFlatsHotel consists of multiple materials. Mainly covered in glass, other features including brick accents, metal panels, and terra cotta finishing make up the building seen at the intersection of College Ave and 7th Street. The contrast in simple materials leaves an appealing building image and gives it a sense of modernity, which is continued throughout the entire hotel. Accompanying the exterior image and fascinating interior design, efficient features can be found in every room. Such features include but are not limited to cork flooring, occupancy sensors, low flow toilets and faucets, fluorescent lighting, Cradle-to-Cradle countertops, and low VOC products.

CityFlatsHotel's structural system will be described throughout this report by taking a closer look at the structural concepts and existing conditions. To understand how the various structural components work, detailed descriptions of the foundation, floor system, lateral system, and gravity system are provided.

Structural Systems

Foundation

Soils & Structures Inc. completed the geotechnical engineering study for the CityFlatsHotel on July 16, 1998. A series of five test borings were drilled in the locations shown in the proposed plan (Figure 1.1). Each test boring was drilled to a depth of 25 feet in order to reveal the types of soil consistent with the location of the site. The results showed that the soil profile consisted of compact light brown fine sand to a depth of 13.0 to 18.0 feet over very compact coarse sand and compact fine silt. In test boring two a small seam of very stiff clay was discovered at 20.0 feet. Groundwater was encountered at a depth of 14.0 feet. From these findings it was recommended that a bearing value of 4000 psf be used for design of rectangular or square spread foundations and a value of 3000 psf be used for strip foundations. Since the test boring was performed in a relatively dry period, it was noted that the water table might rise by as much as 2.0 to 3.0 feet during excessive wet periods.

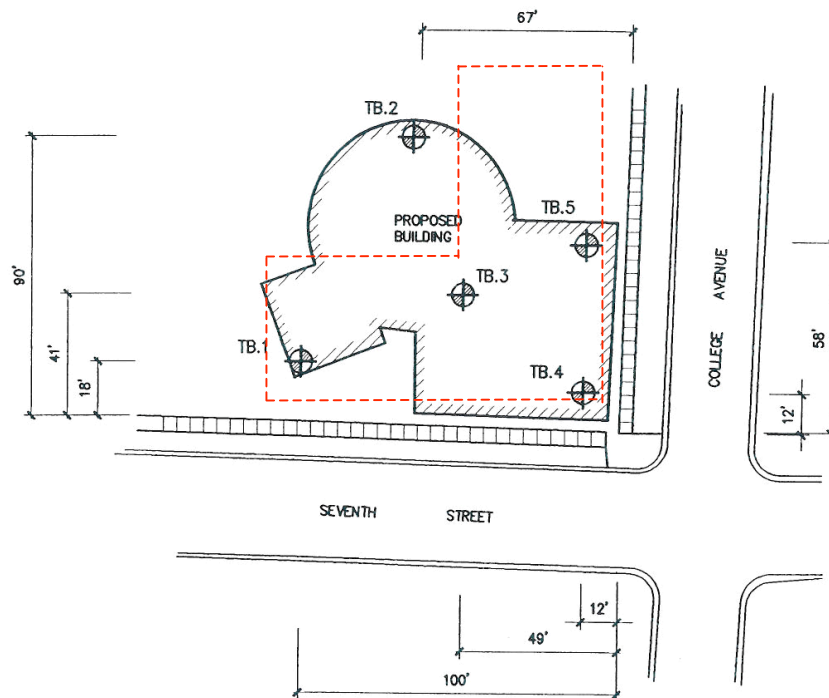


FIGURE 1.1: This is a plan view of the Five Test Boring Locations
Note: The layout of the building here was the proposed shape. The actual building takes on an L-shape as can be seen later in Figure 1.8

1'-8"

1'-0"

1'-0"

1'-0"

4" DIA. PERFORATED DRAINAGE TUBING w/ FILTER FABRIC SOCK

1'-0" EQUAL

1'-0" EQUAL

2" RIGID INSULATION ON INSIDE FACE OF ALL EXTERIOR WALLS

CONCRETE FOUNDATION WALL w/ 5" BARS @ 12" OC HORIZ. (SEE PLAN FOR WALL WIDTH)

5" VERTICAL DOWELS @ 16" OC

SEE FOUNDATION PLANS & FOOTING SCHEDULE FOR SIZE & REINFORCING

EL. 99'-4" UNLESS NOTED OTHERWISE

EL. 96'-4" UNLESS NOTED OTHERWISE

*5 DOWELS x 40" LONG @ 16" OC WHERE NOTED ON PLANS

3

S7.01

1/2" x 1'-0"

TYPICAL EXTERIOR FOUNDATION

Diagram illustrating the typical column footing details:

- CONCRETE OF CONCRETE PIER OR WALL - SEE FOUND. PLANS WHERE REQUIRED & DETAIL 4/S7.01 FOR REINFORCING
- ANCHOR BOLTS AT COLUMN LOCATIONS WHERE NO PIER IS REQUIRED
- SEE FOUNDATION PLANS FOR FOOTING ELEVATION
- SEE FOOTING SCHEDULE FOR SIZE & REINFORCING
- 3" CLR.

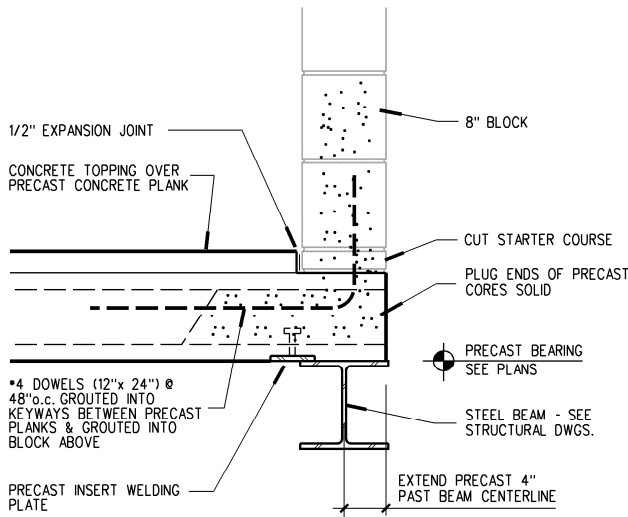
2
S7.01

TYPICAL COLUMN FOOTING

1/2" = 1'-0"

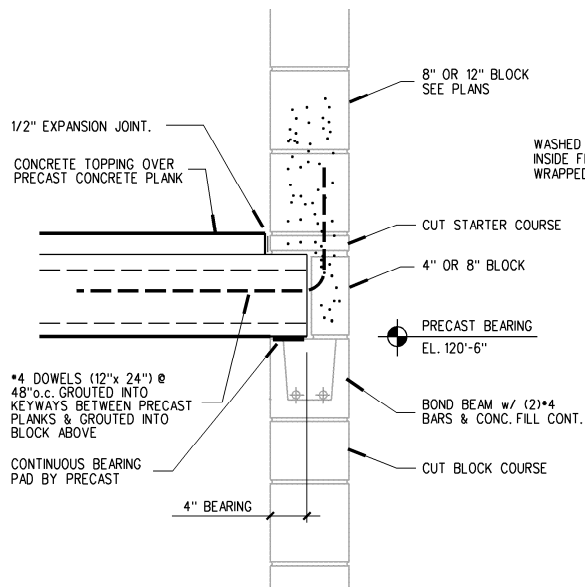
Superstructure

5



10 PRECAST BEARING DETAIL
S7.01 1" = 1'-0"

Figure 1.4: Typical Steel Beam Support Detail

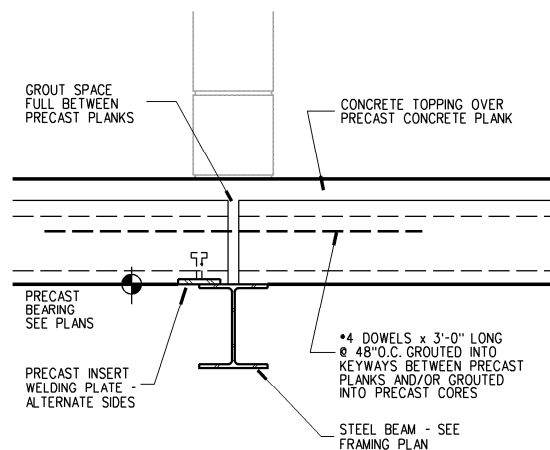


9 PRECAST BEARING DETAIL
S7.01 1" = 1'-0"

Figure 1.5: Typical Masonry Wall Reinforcing

The precast plank allows for quicker erection, longer spans, and open interior spaces. The use of precast plank is typical for all floors other than the basement floor and specific areas of the ground floor, which utilizes slab on grade. All floor slabs on grade are 4" thick except for radiant heat areas, which require the slab to be 5" thick. Both of these slabs are reinforced with 6x6 W2.9x2.9 welded wire fabric.

Masonry walls are also used throughout the building layout to hold up the precast concrete plank floors. Refer to Appendix A for wall locations. These walls simply consist of concrete masonry units that are reinforced with #5 bars vertically spaced at 16" o.c. and extend the full height of the wall (Figure 1.5). In order to connect the precast planks with the masonry block, 4" dowels, typically 3'-0" long spaced at 48" o.c., are grouted into keyways and used to connect the two members together (Figure 1.6).



22 PRECAST BEARING DETAIL
S7.01 1" = 1'-0"

Figure 1.6: Typical Member Connection Detail

Columns add the final support and are typically HSS columns located around the perimeter of the building as well as along the corridors of the hotel. Refer to Appendix A for plans with column locations. HSS 8x8x3/8" columns were typically used on the exterior and HSS 8x8x1/2" columns were used in the interior. HSS 12x12x5/8" were used in order to support the larger beams and greater tributary areas. All load bearing masonry walls and steel beams will take the reaction load from the precast concrete plank flooring, as well as any additional loads from upper levels, and transfer the loads thru the columns and exterior walls thru to the foundation system.

Lateral System

The main lateral system for the CityFlatsHotel consists of the concrete masonry shear walls. The exterior as well as the interior walls are constructed with 8" concrete masonry, which extend the entire height of the building. The core shear walls are located around the staircases and elevator shafts. The average spacing between these walls are 18'-6" and they extend between 22'-6" to 25'-6" in length. In addition to the masonry walls there are steel moment connections in the southeast corner of the building similar to (Figure 1.7), which allows for additional lateral support of the two-story entrance atrium. Moment connections are also utilized on the top floor again similar to (Figure 1.7). This is in order to support the large amounts of glazing that is present, as an architectural feature for the restaurant located there. On floors three to five there are lateral braces used again in the southeast corner of the building that help with resisting the lateral load, which is prominent in the North/South direction. This will be expressed later when calculating wind loads.

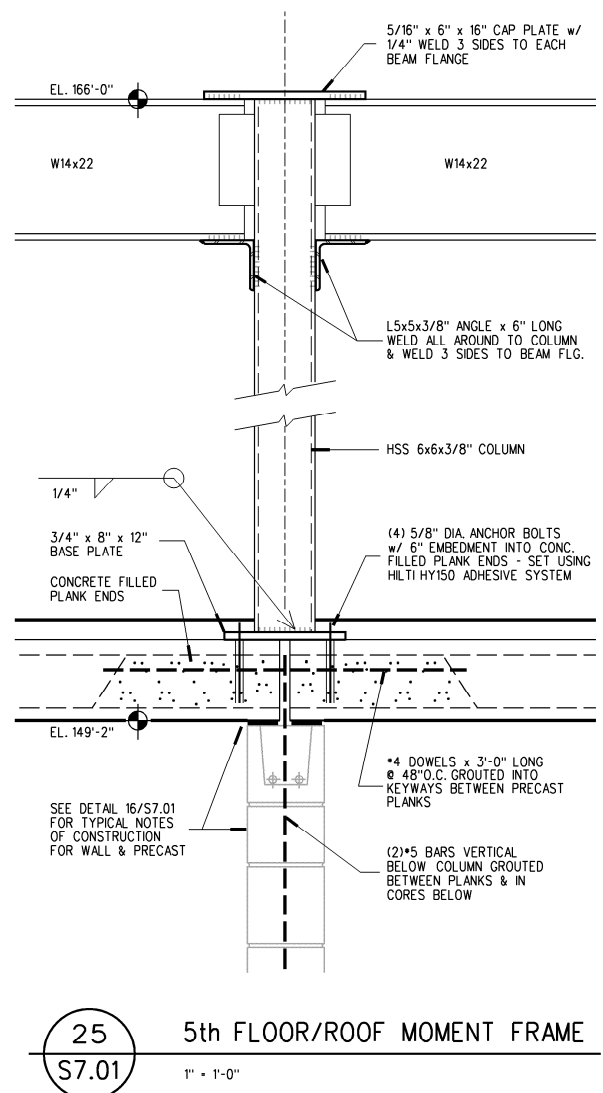


Figure 1.7: Typical Moment Frame Connection

Roof System

The roof framing system like the floor framing system is laid out in a rectangular grid. It consists of 1.5B 20-gauge metal decking supported by K-series joists. The typical joists that are used range between 12K1 and 20K5, which have depths of 12" and 20" respectively. These K-series joists span between 16'-6" to 30'-8". The roof deck spans longitudinally, which is perpendicular to the K-series joists. The joists are spaced no further than 5'-0" apart and typically no shorter than 4'-0".

Codes and References

Codes Used in the Original Design

- 2003 Michigan Building Code
- ASCE 7-05, Minimum Design Loads for Buildings
- ACI 318-05, Building Code Requirements for Structural Concrete
- Specifications for Structural Steel Buildings (AISC)
- International Building Code (IBC), 2006

Codes Used in Analysis

- ASCE 7-05, Minimum Design Loads for Buildings
- ACI 318-05, Building Code Requirements for Structural Concrete
- Specifications for Structural Steel Buildings (AISC), 13th Edition
- International Building Code (IBC), 2009
- PCI Design Handbook, 7th Edition

Materials

Reinforced Concrete

Footings	$f'_c = 3000 \text{ psi}$
Slab On Grade	$f'_c = 4000 \text{ psi}$
Precast	$f'_c = 5000 \text{ psi}$
Precast Topping Slab	$f'_c = 4000 \text{ psi}$

Reinforcement Steel

Deformed Bars	ASTM A615
Welded Wire Fabric	ASTM A185

Structural Steel

Structural W Shapes	ASTM A992
Steel Tubes (HSS Shapes)	ASTM A500
Angles & Plates	ASTM A36
Bolts, Fasteners, & Hardware	ASTM A153

Masonry

8" CMU	$f'_m = 2000 \text{ PSI}$
Grout	$f'_c = 3000 \text{ PSI}$

Design Load Summary

All of the design loads that are used during the analysis of CityFlatsHotel are listed in Table 4.1 below.

Live Loads (LL)		
Area	GMB Design Loads (PSF)	ASCE 7-05 Load (PSF)
Private Guest Rooms	40	40
Public Spaces	100	100
Corridors	100	40 (Private Corridor) / 100 (Public Corridor)
Lobbies	100	100
Stairs	100	100
Storage/Mechanical	125	125 (Light)
Theater (Fixed)	60	60
Restaurant/Bar	100	100
Patio (Exterior)	100	100
Dead Loads (DL)		
Material	GMB Design Loads (PSF)	ASCE 7-05 Load (PSF)
8" Precast w/2" Topping	80	
10" Precast w/2" Topping	92	
8" Masonry Wall, Full Grout w/Rein. @ 16" o.c.	-	
MEP	10	Section 3.1
Partition	25	
Finishes/Miscellaneous	-	
Roof	15	
Snow Load (SL)		
Area	GMB Design Loads (PSF)	ASCE 7-05 (PSF)
Flat Roof	35	35
Ground	50	50

Table 4.1: Summary of Design Loads

Lateral Loads

Wind Analysis

The following wind analysis was conducted in accordance with ASCE 7-05, chapter 6. Since the overall building height exceeds 60'-0" and reaches a height of 67'-2", it is required, as it is stated in Section 6.5, to use Method 2 – Analytical Procedure, as apposed to Method 1 – Simplified Procedure. All of the wind variables used in determining the wind pressures can be found in Table 5.1. For complete analysis calculations refer to Appendix C. The North/South and East/West wind directions are labeled on the typical floor plan in Figure 5.1.

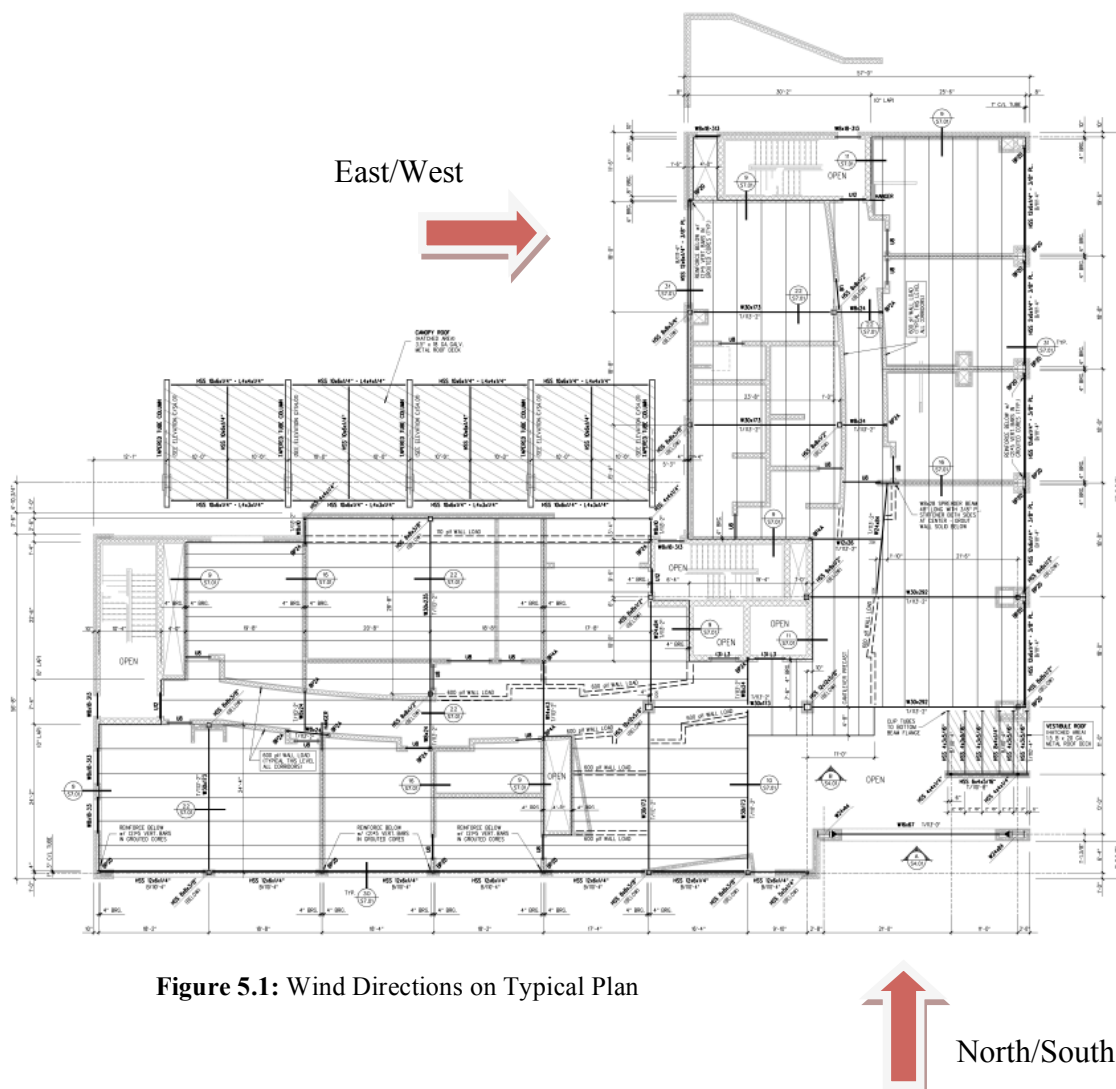


Figure 5.1: Wind Directions on Typical Plan

Wind Variables			ASCE Reference
Name	Symbol	Value	
Basic Speed	V	90 mph	Figure 1
Directional Factor	K_d	0.85	Table 6-4
Importance Factor	I	1.0	Table 6-1
Occupancy Category		II	Table 1-1
Exposure Category		B	Section 6.5.6.3
Enclosure Classification		Enclosed	Section 6.5.9
Building Natural Frequency	n_1	2.31 (Rigid)	See Below
Topographic Factor	K_{zt}	1.0	Section 6.5.7.2
Velocity Pressure Exposure Coefficient Evaluated @ Height Z	K_z	Varies	Table 6-3
Velocity Pressure @ Height Z	q_z	Varies	Equation 6-15
Velocity Pressure @ Mean Roof Height	q_h	0.87	Equation 6-15
Gust Effect Factor	G	0.85	Section 6.5.8.1
Product of Internal Pressure Coefficient & Gust Effect Factor	GC_{pi}	+/- 0.18	Figure 6-5
External Pressure Coefficient (Windward)	C_p	0.8 (All Values)	Figure 6-5
External Pressure Coefficient (Leeward)	C_p	-0.5 (North/South)	Figure 6-5
		-0.2 (East/West)	

Table 5.1: Wind Variables and Reference Sections

Building Natural Frequency Equation:

$$f_{n1} = (150/H) \text{ where } H = \text{Building Height (ft.)}$$

$$f_{n1} = (150/67.167) = 2.23 \geq 1 \text{ Hz} \quad \therefore \text{the building is considered to be rigid.}$$

The wind pressures in the North/South direction that were determined in the analysis are in Table 5.2 located below. Wind traveling in the North/South direction is the dominate direction since it has contact with the building through a wall of length 154'-4" as compared to the East/West direction which only has contact with a wall of length 116'-5 3/8". Obstruction from the front and back of the hotel will not cause a significant wind load blockage, so any surrounding hindrances have been ignored during the analysis. In Figure 5.2 the windward and leeward pressures at all levels of CityFlatsHotel as well as the base shear can be seen on the building elevation. A basic loading diagram is also provided in Figure 5.3, which shows wind loads and story shears produced from wind coming from the North/South direction.

Wind Loads - North/South Direction													
Level	Height Above Ground, z (ft.)	Story Height (ft.)	K _z	q _z	Wind Pressure (PSF)		Total Pressure (PSF)	Force of Total Pressure (k)	Force of Windward Pressure Only (k)	Total Story Shear (k)	Windward Story Shear (k)	Total Moment (ft-k)	Windward Moment (ft-k)
					Windward	Leeward							
Top of Roof	67.17	2.25	0.88	15.5	13.24	-9.06	22.3	3.87	2.30	3.87	2.30	0.00	0.00
Roof	64.92	14.92	0.87	15.3	13.12	-9.06	22.2	29.42	17.41	33.29	19.71	66.19	39.17
Fifth	50.00	12.00	0.81	14.3	12.40	-9.06	21.5	45.42	26.60	78.71	46.30	743.90	435.99
Fourth	38.00	12.00	0.75	13.2	11.69	-9.06	20.7	39.09	22.31	117.80	68.61	1213.00	703.68
Third	26.00	12.00	0.67	11.8	10.73	-9.06	19.8	37.54	20.75	155.34	89.37	1663.46	952.72
Second	14.00	12.00	0.57	10.0	9.53	-9.06	18.6	35.54	18.76	190.88	108.12	2089.94	1177.79
First	0.00	14.00	0.00	0.0	0.00	0.00	0.0	17.22	8.82	208.10	116.94	2296.52	1283.67

Table 5.2: North/South Wind Loads

Sum 208.10 116.94 2296.52 1283.67

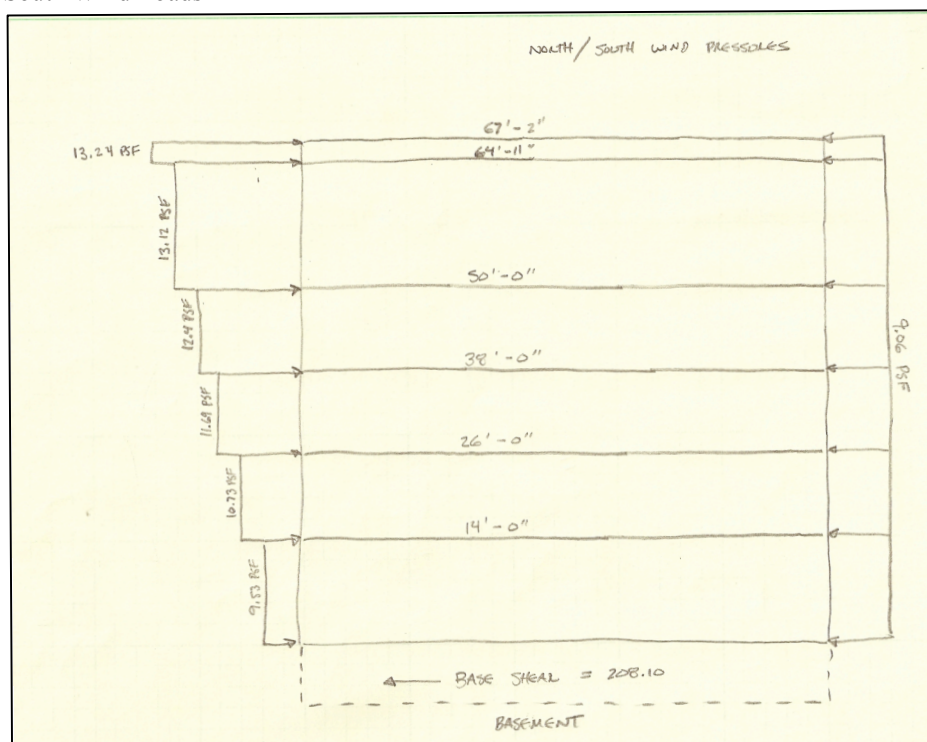


Figure 5.2: North/South Wind Pressures

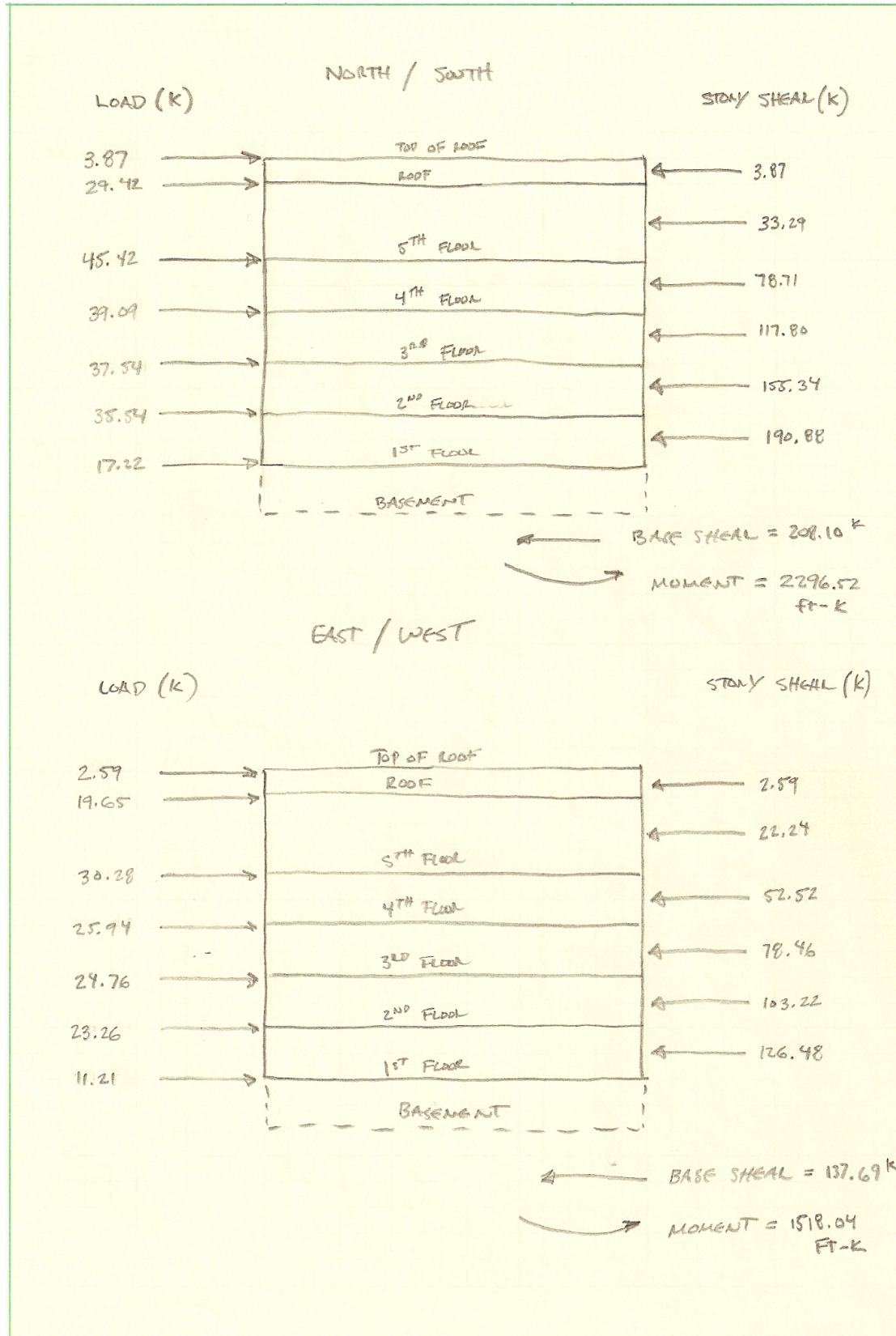


Figure 5.3: Shear and Moment Loading Diagrams

The wind pressures in the East/West direction that were determined in the analysis are in Table 5.3 located below. Any buildings that may be surrounding CityFlatsHotel can have effects on the full wind loading, however the wind loading must be examined as if buildings were not present. In Figure 5.4 the windward and leeward pressures at all levels of CityFlatsHotel as well as the base shear can be seen on the building elevation. A basic loading diagram is also provided in Figure 5.3, which shows wind loads and story shears produced from wind coming from the East/West direction.

Wind Loads - East/West Direction													
Level	Height Above Ground, z (ft.)	Story Height (ft.)	K_z	Q_z	Wind Pressure (PSF)		Total Pressure (PSF)	Force of Total Pressure (k)	Force of Windward Pressure Only (k)	Total Story Shear (k)	Windward Story Shear (k)	Total Moment (ft-k)	Windward Moment (ft-k)
					Windward	Leeward							
Top of Roof	67.17	2.25	0.88	15.5	13.24	-6.52	19.8	2.59	2.30	2.59	2.30	0.00	0.00
Roof	64.92	14.92	0.87	15.3	13.12	-6.52	19.6	19.65	13.14	22.24	15.44	44.21	29.55
Fifth	50.00	12.00	0.81	14.3	12.40	-6.52	18.9	30.28	20.07	52.52	35.50	496.01	328.96
Fourth	38.00	12.00	0.75	13.2	11.7	-6.52	18.2	25.94	16.83	78.46	52.34	807.25	530.94
Third	26.00	12.00	0.67	11.8	10.7	-6.52	17.2	24.76	15.66	103.22	67.99	1104.43	718.85
Second	14.00	12.00	0.57	10.0	9.5	-6.52	16.0	23.26	14.15	126.48	82.15	1383.52	888.67
First	0.00	14.00	0.00	0.0	0.0	0.00	0.0	11.21	6.66	137.69	88.80	1518.04	968.55
Sum										137.69	88.80	1518.04	968.55

Table 5.3: East/West Wind Loads

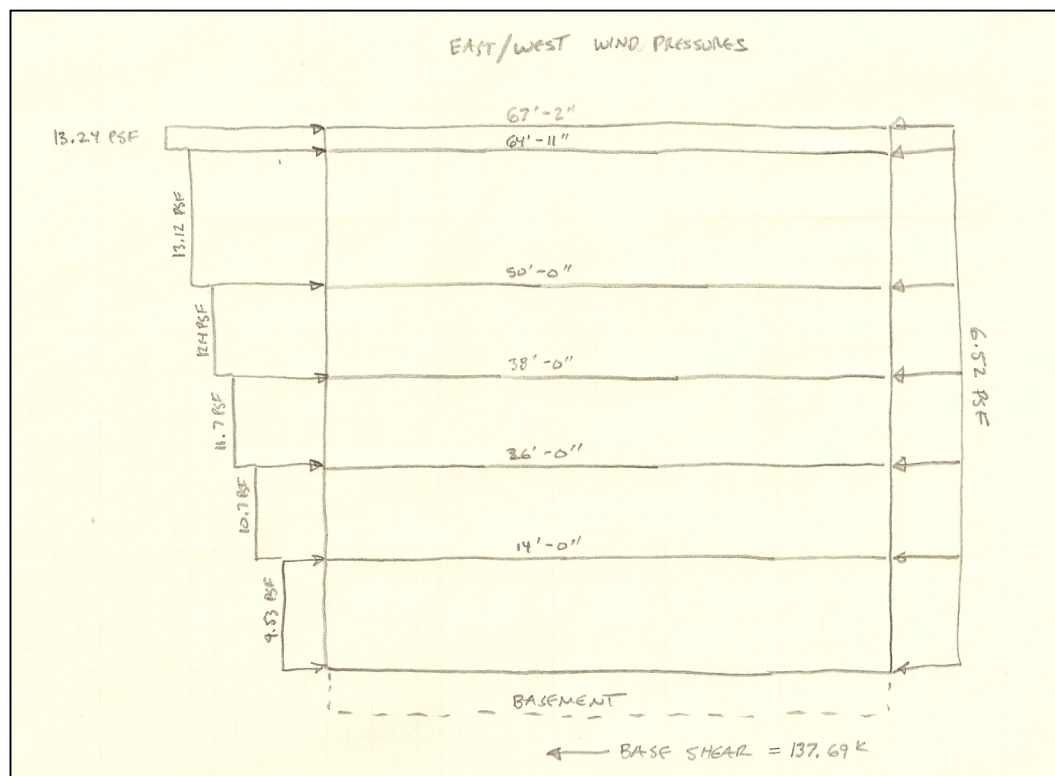


Figure 5.4: East/West Wind Pressures

Seismic Analysis

The seismic analysis of CityFlatsHotel was conducted in accordance with ASCE 7-05 chapters 11 and 12. The building was designed to resist the effects of earthquakes using a Site Class for Seismic Design of “D”. This is in accordance with the IBC. All variables that were used while conducting this analysis are listed in Table 5.4 It is important to note that seismic loads in the North/South direction is the same as loads in the East/West direction due to the structural type being the same throughout. However, it is important to note that the impact may be different due to the geometry, center of rigidity, framing layout, ect.

Seismic Design Variables			
Site Class		D	Table 20.3-1
Occupancy Factor		II	Table 1-1
Importance Factor		1.0	Table 11.5-1
Structural System		Ordinary Reinforced Masonry Wall	Table 12.2-1
Spectral Response Acceleration, Short	S_s	0.098	Figure 22-1 thru 22-14
Spectral Response Acceleration, 1s	S_1	0.045	Figure 22-1 thru 22-15
Site Coefficient	F_a	1.6	Table 11.4-1
Site Coefficient	F_v	2.4	Table 11.4-2
MCE Spectral Response Acceleration, Short	S_{ms}	0.1568	Equation 11.4-1
MCE Spectral Response Acceleration, 1s	S_{m1}	0.1080	Equation 11.4-2
Design Spectral Acceleration, Short	S_{ds}	0.1045	Equation 11.4-3
Design Spectral Acceleration, 1s	S_{d1}	0.0720	Equation 11.4-4
Seismic Design Category	S_{dc}	B	Table 11.6-2
Response Modification Coefficient	R	2.0	Table 12.2-1
Building Height (Above Grade) [ft.]	h_n	67.167	From Design
Calculated Period Upper Limit Coefficient	C_t	0.02	Table 12.8-1
Approximate Period Parameter	X	0.75	Table 12.8-2
Approximate Period Parameter	C_u	1.7	Table 12.8-2
Approximate Fundamental Period	T_a	0.469	Equation 12.8-7
Fundamental Period	T	0.797	Section 12.8.2
Long Period Transition Period	T_L	12	Figure 22-12
Seismic Response Coefficient	C_s	0.0452	Equation 12.8-2
Structural Period Exponent	k	1.1485	Section 12.8.3

Table 5.4: Seismic Design Variables

In order to effectively calculate the overturning moments and base shear due to seismic loads, it was necessary to calculate the buildings total weight, which was done by determining each individual floors weight. Refer to Appendix D for the detailed calculations of each floors weight. In Table 5.5 the base shear and overturning moments due to seismic loading for each story level can be found. In Figure 5.5 a seismic loading diagram can be seen which shows the story forces and story shears at each floor level.

Base Shear and Overturning Moment Distribution									$k = 1.1485$ $V = 463.7$
Story	Floor Area	h_x (ft.)	Story Weight (PSF)	Story Weight (k)	$w_x h_x^k$	C_{vx}	Lateral Force F_x (k)	Story Shear V_x (k)	M_x (ft-k)
First	12235	0.0	177.26	2168.78	0	0.00	0.00	463.70	0.0
Second	12200	14.0	160.42	1957.12	40546	0.09	41.12	463.70	287.8
Third	12200	26.0	160.39	1956.76	82534	0.18	83.70	422.58	1674.0
Fourth	12200	38.0	160.56	1958.83	127755	0.28	129.56	338.88	4146.0
Fifth	12200	50.0	162.79	1986.04	177523	0.39	180.04	209.31	7921.6
Roof	11500	67.2	20.00	230.00	28871	0.06	29.28	29.28	1715.8
Total									10258 457229

Table 5.5: Base Shear and Overturning Moment

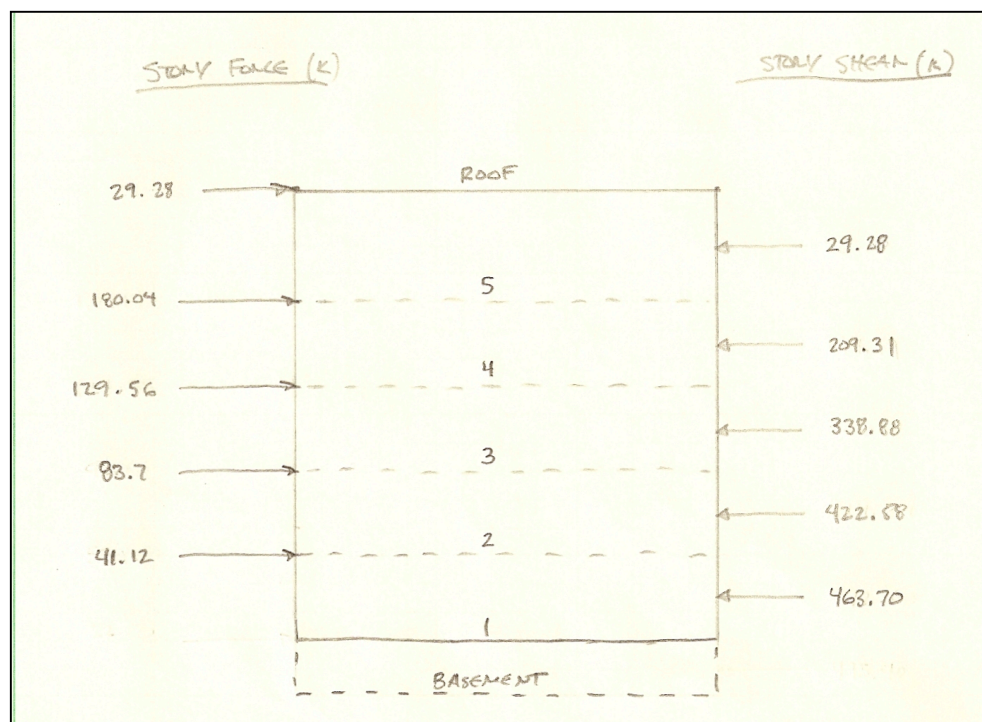


Figure 5.5: Story Force and Story Shear

Spot Checks

In order to confirm the framing elements used in CityFlatsHotel structural design, a series of spot checks were calculated. The spot checks that were performed include checks on an interior column, a beam, and the longest span of the precast plank. There may be slight variations in calculations due to spot checks being done only using applied gravity loads and not taking into account any lateral loads that may be present. For detailed calculations of the spot checks refer to Appendix E. The spot checks performed can be seen in Figure 6.1.

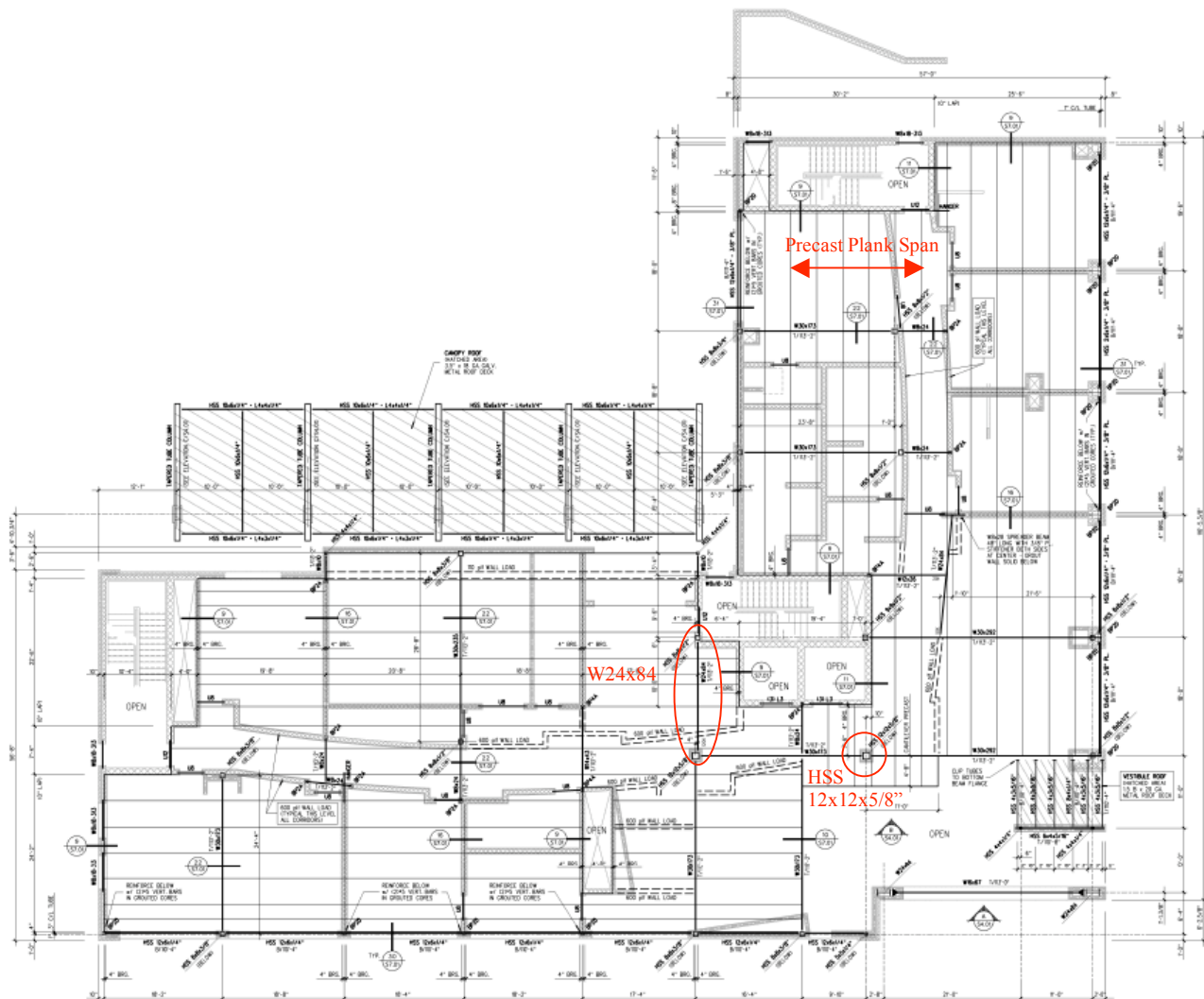


Figure 6.1: Spot Check Members

Spot checks were performed on an interior steel column, an interior steel beam as well as on the typical precast plank floor, all of which were located on the first floor. In order to complete the check on the interior column it was necessary to use the floor weights, which were calculated in the seismic analysis, as well as the live loads present on each floor. A summary of the loads on the columns can be seen in Table 6.1 below.

Column Loads								
Level Supported	Tributary Area (SF)	Dead Load (PSF)	Live Load (PSF)	Live Load Reduction (PSF)	Dead Load (k)	Live Load (k)	Total Load (1.2D+1.6L) [kips]	Accumulated Load (k)
Basement	689	85.67	100	100	59.0	68.9	181.1	1128.8
First	689	177.26	100	100	122.1	68.9	256.8	947.7
Second	689	160.42	55	29.48	110.5	20.3	165.1	690.9
Third	689	160.39	55	29.48	110.5	20.3	165.1	525.8
Fourth	689	160.56	55	29.48	110.6	20.3	165.2	360.7
Fifth	689	162.79	55	29.48	112.2	20.3	167.1	195.4
Roof	689	20.00	20	10.72	13.8	7.4	28.4	28.4

Table 6.1: Column Loads

For the spot check of the interior column, tributary area was considered and allowed for utilization of live load reduction on the hotel live loads and partition live loads. Only axial forces due to gravity loads were applied, which leads cause for error by not taking any additional forces into consideration. The unbraced length was determined by excluding any shear walls that may in fact shorten the unbraced length. This discrepancy results in variations in outcomes. For detailed calculations of the floor loads on the column refer to Appendix E.

The spot check for the interior beam, which was a W24x84, was determined to be able to carry the bending moment due to the weight of the construction load. It was also checked out for factored moment due to dead loads, allowable deflection and deflection under construction loads. For detailed calculations of this spot check refer to Appendix E.

The last spot check was for the precast plank flooring system. Examining the maximum span of the plank and calculating the dead and live loads for each floor allows for proper comparison to the technical specifications. Unfortunately, the specifications were not provided for the precast plank, but it was determined that the precast plank must be able to withstand a factored load of 100 PSF at its maximum span. Detailed calculations can be found in Appendix E.

Conclusion

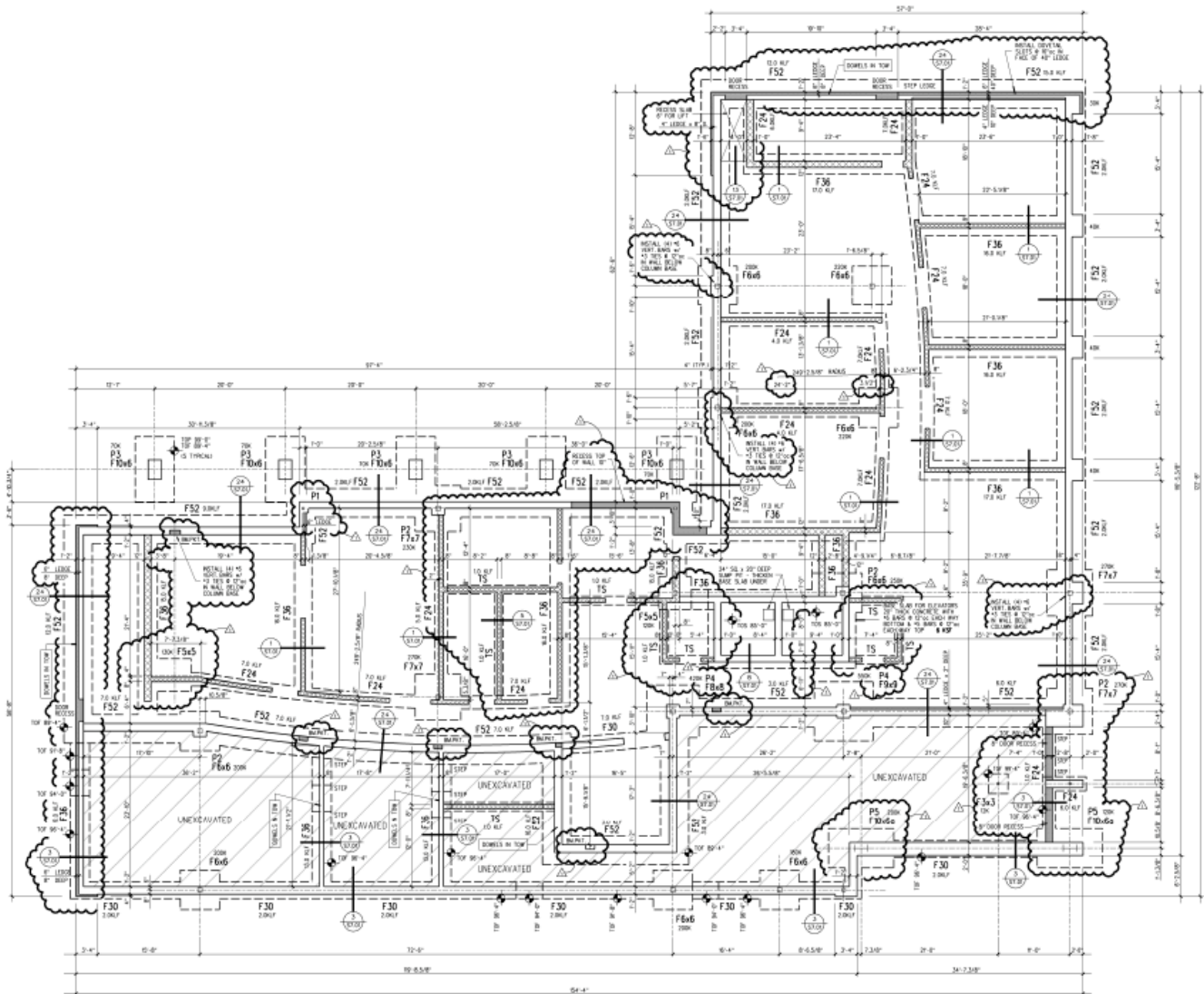
The analysis of the existing conditions for CityFlatsHotel allowed for a better understanding of how the various structural systems work and how they work together as a whole. After the completion of spot checks of gravity loads only of CityFlatsHotel it was found to be designed according to code and can withstand all forces that are applied to the structure.

The structure includes reinforced masonry walls, which extend to the top floor of the building, steel beams and columns. It is a multi-system structural system that has a lateral system that is made up of primary masonry shear walls; some isolated moment frames, as well as brace frames which are located in the southeastern corner of the building. These additional features are located at this part of the building due to the amount of loading there is from this corner.

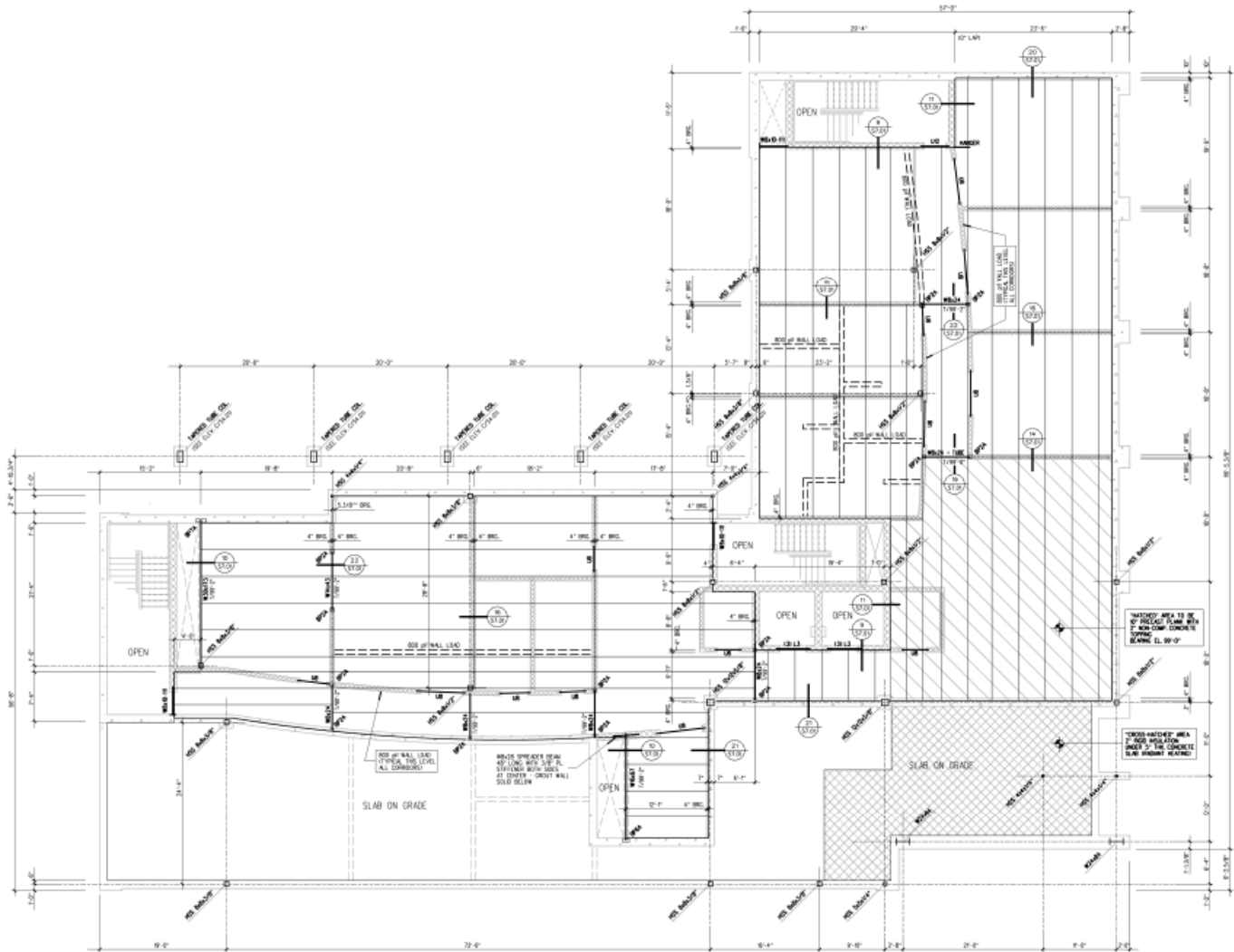
ASCE 7-05 was used in both the wind and seismic analysis, which was a check for the lateral forces against the structure. The result was that the North/South wind loads were the largest. This is due to the fact that there is a much longer façade that sits perpendicular to the wind in this direction as opposed to the East/West direction. Without considering torsion effect, seismic loads create a much greater base shear than wind loads. This shows that the distribution is different at the various elevations, and members may be controlled by different conditions.

Various calculations were completed on gravity members to verify the structural design. Spot checks were completed on three different components, which include an interior column, and interior beam, and the precast concrete plank. Through these calculations it was verified that the interior beam was sufficient to carry the design loads. The interior column was not found to match. The difference in assumptions used in the analysis compared to what was used in the actual design of CityFlatsHotel may account for some of the variation in results. Errors include differences in unbraced lengths as well as a miss understanding of a multi system structure. The simplicity of the analysis could also have an affect on the outcome. Further research and calculations will include additional forces as a deeper understanding of the entire structural system is developed.

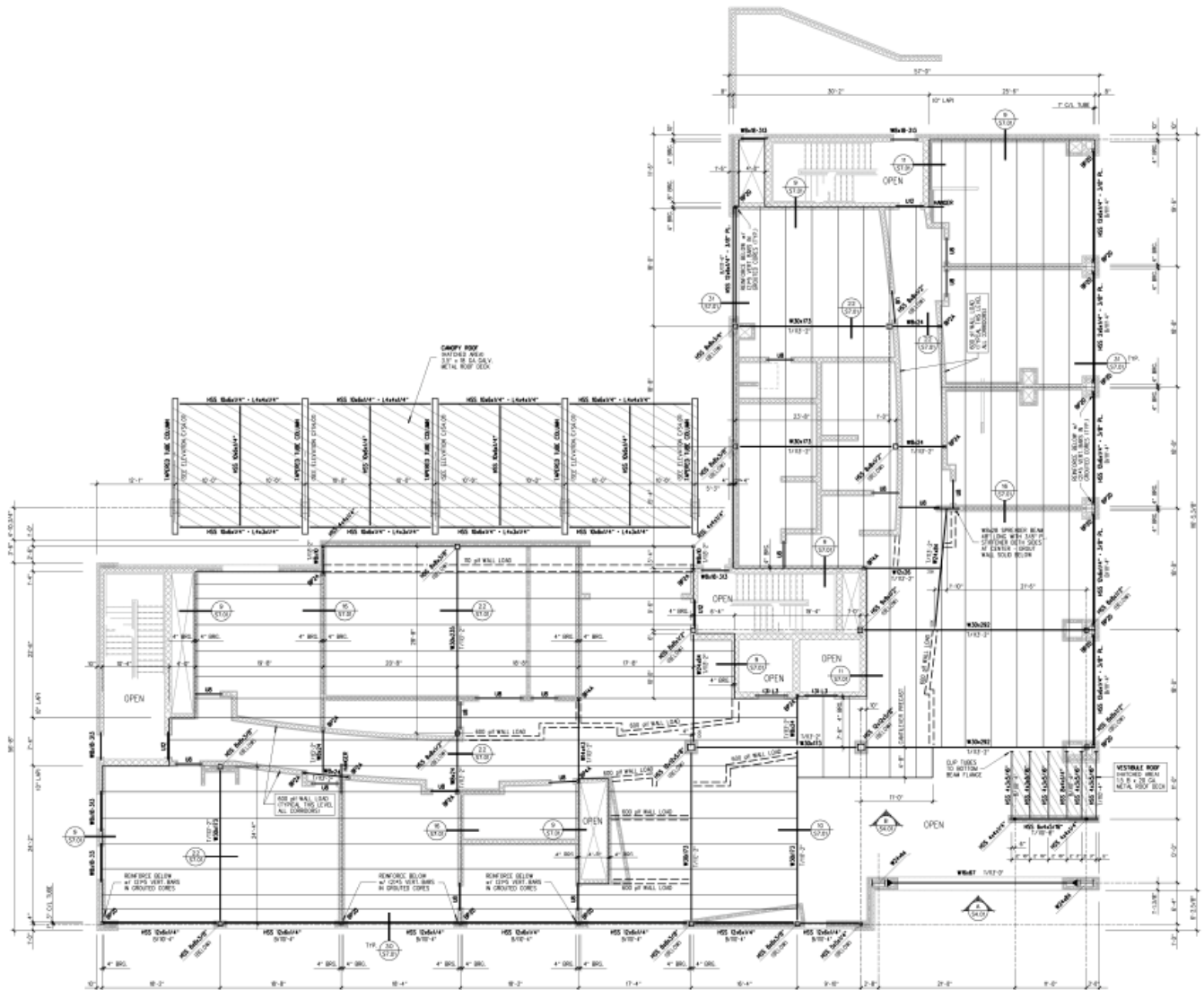
Appendix A: Plans



Foundation Plan



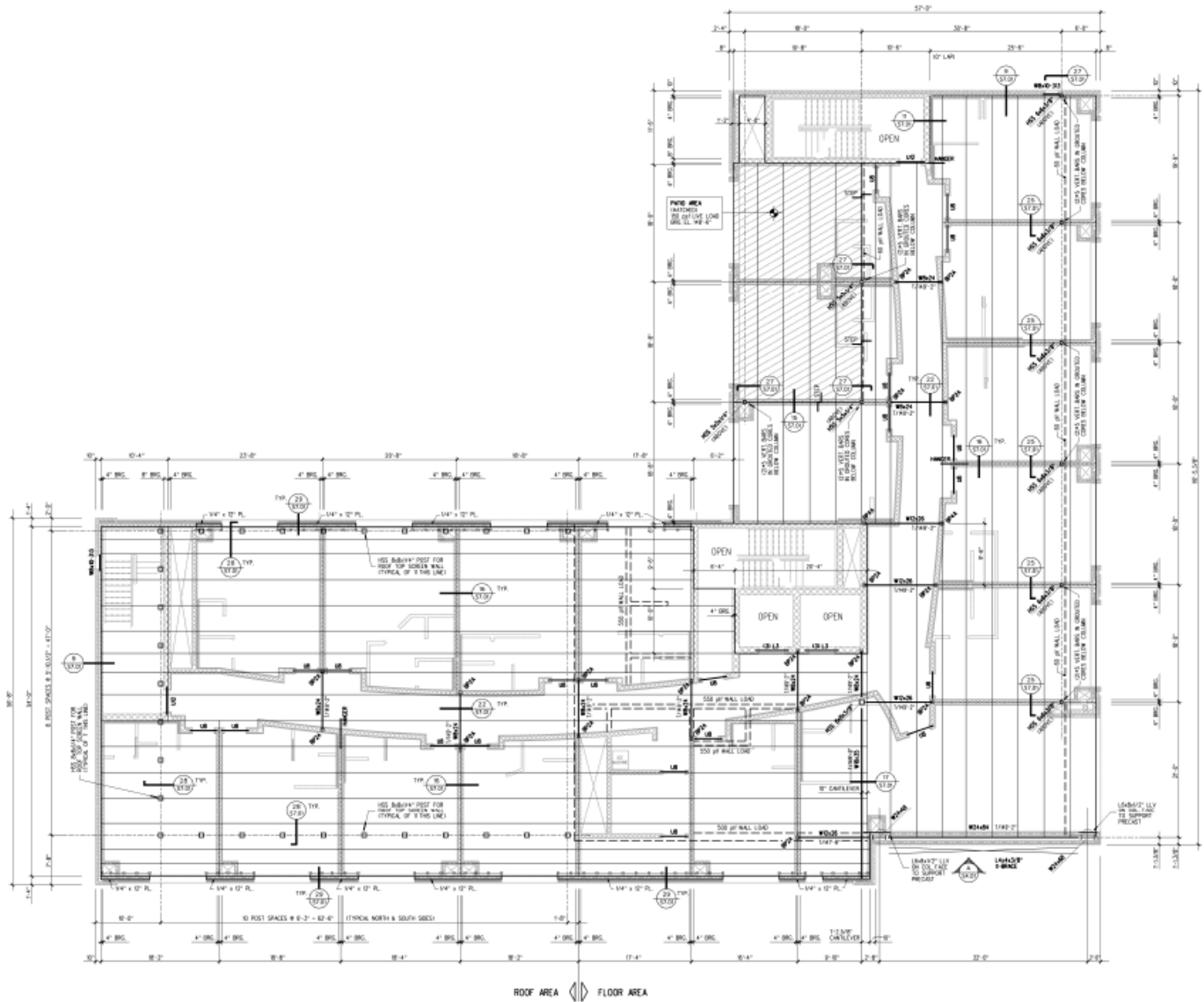
First Level Framing Plan



Second Level Framing Plan







Fifth Level Framing Plan



Appendix B: Snow Load Analysis

SNOW LOADS

• GROUND SNOW LOAD (P_g) $P_g = 50 \text{ PSF}$ (FIGURE 7-1)

• NOTE GMB USED 50 PSF

• FLAT ROOF SNOW LOAD (P_f)

$$P_f = 0.7 C_e C_t I P_g > 20(I) \quad \text{SINCE } P_g \text{ EXCEEDS } 20 \text{ PSF (EQ. 7-1)}$$

$C_e = \text{EXPOSURE FACTOR} = 1.0$ SINCE PARTIALLY EXPOSED (TABLE 7-2)
AND EXPOSURE B (SECT. 6.5.6)

$C_t = \text{THERMAL FACTOR} = 1.0$ (TABLE 7-3)

$I = \text{IMPORTANCE FACTOR} = 1.0$ SINCE OCCUPANCY II (TABLE 7-4)
AND (TABLE 1-1)

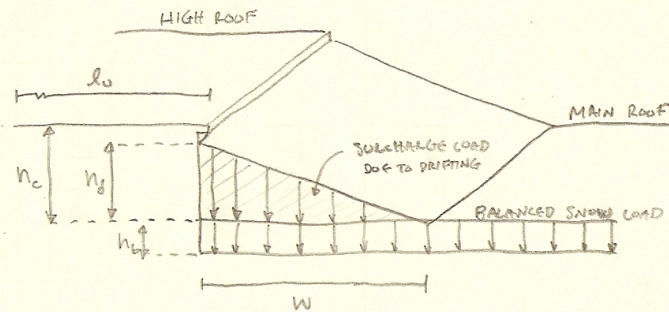
$$P_f = 0.7(1.0)(1.0)(1.0)(50 \text{ PSF}) = 35 \text{ PSF} > 20(1) = 20 \text{ PSF}$$

$\therefore$ OK TO USE

SNOW DRIFT

(SECTION 7.7)

- CALCULATED DUE TO HIGHER PORTIONS OF THE BUILDING AS WELL AS ADJACENT STRUCTURES.



(FIGURE 7-8)

l_o = LENGTH OF ROOF UPWIND DRIFT (ft)

h_c = CLEAR HEIGHT FROM TOP OF BALANCED SNOW LOAD TO CLOSEST POINT ON HIGH ROOF (ft)

h_d = HEIGHT OF SNOW DRIFT (ft)

W = DISTANCE FROM EAVE TO RIDGE (ft)

$$\delta = 0.13 P_g + 14 = 0.13(50 \text{ psf}) + 14 = 20.5 \text{ psf} < 30 \text{ psf} \therefore \text{OK}$$

$$h_d = 0.43 \sqrt[3]{l_o} \sqrt[4]{P_g + 10} - 1.5 \quad \text{WHERE } l_o = 154' - 4'' \text{ (N/S)} \\ l_o = 116' - 5\frac{3}{8}'' \text{ (E/W)}$$

$$\text{SO } h_d = 4.92 \text{ (N/S)} \text{ AND } 4.34 \text{ (E/W)}$$

$$h_b = P_g / \delta = 50 / 20.5 = 2.439 \text{ ft}$$

$$W = 4h_d = 4(4.92) = 19.68' \text{ (N/S)}$$

$$= 4(4.34) = 17.36' \text{ (E/W)}$$

* IF $h_c/h_b < 0.2$ DRIFT LOADS ARE NOT REQUIRED TO BE APPLIED

Appendix C: Wind Load Analysis

WIND LOADS

METHOD 2 - ANALYTICAL PROCEDURE

WIND VARIABLES: $V = 90$ MPH $K_d = 0.85$ $I = 1.0$ $K_{zt} = 1.0$ EXPOSURE B

K_z VALUES AT DIFFERENT FLOOR HEIGHTS
FROM TABLE 6-3
CASE II

* MOST INTERPOLATE FOR
PROPER K_z VALUES

LEVEL	HEIGHT ABOVE GRADE	K_z FACTOR
FIRST FLOOR	0' - 0"	0
SECOND FLOOR	14' - 0"	0.57
THIRD FLOOR	26' - 0"	0.668 *
FOURTH FLOOR	38' - 0"	0.748 *
FIFTH FLOOR	50' - 0"	0.81 *
ROOF	64' - 11"	0.87 *
TOP OF ROOF	67' - 2"	0.879 *

* INTERPOLATION FORMULA:
$$Y_2 = \frac{(x_2 - x_1)(Y_3 - Y_1)}{(x_3 - x_1)} + Y_1$$

$$q_z = 0.00256 K_z K_{zt} K_d V^2 I$$

$$= 0.00256 K_z (1.0)(0.85)(90)^2(1.0) = 17.6256 K_z$$

PLUG K_z VALUE INTO EQUATION TO GET q_z VALUE AT PROPER HEIGHT
THESE VALUES ARE FOUND IN THE TABLE

$$\begin{aligned} q_h &= 0.00256 K_z K_{zt} K_d V^2 I \quad \text{WHERE } \bar{z} = \frac{67'-2" + 52'-8"}{2} = 59'-11" \\ &= 0.00256 (0.85)(1.0)(0.85)(90)^2(1.0) \quad \Rightarrow K_z = 0.85 \\ &= 14.98 \text{ PSF} \end{aligned}$$

CHECK $\bar{z} = 0.6h > \bar{z}_{min}$

$$0.6(59.917) = 35.95 > 30'$$

* $\bar{z}_{min}$ FROM TABLE 6-2

WIND LOADS (CONTINUED)

• EXTERNAL PRESSURE COEFFICIENTS (C_p)

NORTH/SOUTH

$$\begin{aligned} \text{LEEWARD} &= -0.5 \\ \text{WINDWARD} &= 0.8 \end{aligned}$$

$$L/B = 0.75$$

$$L = 116'-5\frac{3}{8}" \quad B = 154'-4"$$

EAST/WEST

$$\begin{aligned} \text{LEEWARD} &= -0.3 \\ \text{WINDWARD} &= 0.8 \end{aligned}$$

$$L/B = 1.33$$

$$L = 154'-4" \quad B = 116'-5\frac{3}{8}"$$

• WIND PRESSURE

$$P_z = q_z G C_p - q_h G C_{pi} \quad (\text{WINDWARD})$$

$$P_h = q_h G C_p - q_h G C_{pi} \quad (\text{LEEWARD})$$

} EQUATION 6-17
 FROM SECTION 6.5.12.2

NORTH/SOUTH @ SECOND LEVEL

$$\begin{aligned} P_z &= (10.05)(0.85)(0.8) - (14.98)(-0.18) \\ &= 9.53 \text{ PSF} \end{aligned}$$

$$\begin{aligned} P_h &= (14.98)(0.85)(0.5) - (14.98)(0.18) \\ &= -9.06 \text{ PSF} \end{aligned}$$

EAST/WEST @ SECOND LEVEL

$$\begin{aligned} P_z &= (10.05)(0.85)(0.8) - (14.98)(-0.18) \\ &= 9.53 \text{ PSF} \end{aligned}$$

$$\begin{aligned} P_h &= (14.98)(0.85)(-0.3) - (14.98)(0.18) \\ &= -6.52 \text{ PSF} \end{aligned}$$

WIND PRESSURES CALCULATED FOR EACH LEVEL AND PUT IN TABLE

WIND LOADS (CONTINUED)

• FORCE OF TOTAL PRESSURE: $F_T = B (\text{STORY HEIGHT}) P_{\text{TOTAL}}$

NORTH/SOUTH @ SECOND LEVEL

$$F_T = [(19.8 \text{ PSF})(6) + (18.6)(6)] (154.33) = 35.6 \text{ K}$$

EAST/WEST @ SECOND LEVEL

$$F_T = [(17.2 \text{ PSF})(6) + (16.0)(6)] (116.45) = 23.2 \text{ K}$$

• FORCE OF WINDWARD ONLY: $F_W = B (\text{STORY HEIGHT}) P_2$

NORTH/SOUTH @ SECOND LEVEL

$$F_W = [(10.73)(6) + (9.53)(6)] (154.33) = 18.8 \text{ K}$$

EAST/WEST @ SECOND LEVEL

$$F_W = [(10.73)(6) + (9.53)(6)] (116.45) = 14.2 \text{ K}$$

• TOTAL STORY SHEAR: $F = F_T e (\text{TOP OF LOOF} + \text{ROOF} + \text{FIFTH})$

NORTH/SOUTH @ FIFTH LEVEL

$$F = (3.87 + 29.42 + 45.42) = 78.21 \text{ K}$$

EAST/WEST @ FIFTH LEVEL

$$F = (2.59 + 19.65 + 30.28) = 52.52 \text{ K}$$

• WINDWARD STORY SHEAR: $F = F_W e (\text{TOP OF LOOF} + \text{ROOF} + \text{FIFTH})$

NORTH/SOUTH @ FIFTH LEVEL

$$F = (2.30 + 17.41 + 26.60) = 46.30 \text{ K}$$

EAST/WEST @ FIFTH LEVEL

$$F = (2.30 + 13.14 + 20.07) = 35.50 \text{ K}$$

Appendix D: Seismic Load Analysis

Seismic Force Resisting System: Basement				
Approximate Area (SF)			8911	
Floor to Floor Height (ft.)			10	
Walls				
Perimeter (ft.)			530	
Height (ft.)			10	
Unit Weight (PSF)			91	
Weight (k)			482.3	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			267.33	
Slab				
Slab Weight is Not Included in Calculation				
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 4x4x1/2"	2	21.5	10	0.43
HSS 8x8x3/8"	5	37.61	10	1.88
HSS 8x8x1/2"	6	48.72	10	2.92
HSS 9x9x1/2"	1	55.53	10	0.56
HSS 12x12x5/8"	2	93.14	10	1.86
Totals	16	256.5		7.65
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x10	3	10	4	0.12
W8x24	6	24	6.5	0.94
W14x43	1	43	8	0.34
W16x67	1	67	16	1.07
W30x173	1	173	21.25	3.68
Totals	12	317		6.15

Total Weight of Floor (k)	763.43
Total Weight of Floor (PSF)	85.67

Seismic Force Resisting System: First Floor				
Approximate Area (SF)			12235	
Floor to Floor Height (ft.)			14	
Walls				
Perimeter (ft.)			570	
Height (ft.)			14	
Unit Weight (PSF)			91	
Weight (k)			726.18	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			367.05	
Slab				
Thickness (in.)			8	10
Unit Weight (PSF)			80	92
Weight (k)			877.12	116.932
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 4x4x1/2"	4	21.5	14	1.20
HSS 5x5x1/4"	1	15.58	14	0.22
HSS 8x8x3/8"	7	37.61	14	3.69
HSS 8x8x1/2"	6	48.72	14	4.09
HSS 9x9x1/2"	1	55.53	14	0.78
HSS 12x12x5/8"	2	93.14	14	2.61
W24x84	2	84	14	2.35
Totals	23	356.08		14.94
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x10	2	10	4	0.08
W8x18	6	10	5	0.30
W8x24	5	24	6.5	0.78
W12x26	1	26	11	0.29
W14x43	1	43	8	0.34
W16x67	1	67	30	2.01
W24x84	2	84	17.5	2.94
W30x173	6	173	24	24.91
W30x235	1	235	28.67	6.74
W30x292	2	292	34.67	20.25
HSS 4x3x5/16"	5	12.67	11	0.70
HSS 8x4x1/2"	1	35.11	11	0.39
HSS 12x6x1/4"	13	29.19	18	6.83
Totals	15	113		66.55

Total Weight of Floor (k)	2168.77
Total Weight of Floor (PSF)	177.26

Seismic Force Resisting System: Second Floor				
Approximate Area (SF)			12200	
Floor to Floor Height (ft.)			12	
Walls				
Perimeter (ft.)			555	
Height (ft.)			12	
Unit Weight (PSF)			91	
Weight (k)			606.06	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			366	
Slab				
Thickness (in.)			8	
Unit Weight (PSF)			80	
Weight (k)			976	
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 8x8x3/8"	1	37.61	12	0.45
W24x84	2	84	12	2.02
Totals	3	121.61		2.47
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x10	2	10	4	0.08
W8x24	8	24	6.5	1.25
W12x16	1	16	21	0.34
W12x26	4	26	11	1.14
W18x35	1	35	27	0.95
W24x84	1	84	32	2.69
C 4x5.4	8	5.4	4.5	0.19
Totals	25	195		6.64

Total Weight of Floor (k)	1957.16
Total Weight of Floor (PSF)	160.42

Seismic Force Resisting System: Third Floor				
Approximate Area (SF)			12200	
Floor to Floor Height (ft.)			12	
Walls				
Perimeter (ft.)			555	
Height (ft.)			12	
Unit Weight (PSF)			91	
Weight (k)			606.06	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			366	
Slab				
Thickness (in.)			8	
Unit Weight (PSF)			80	
Weight (k)			976	
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 8x8x3/8"	1	37.61	12	0.45
W24x68	2	68	12	1.63
Totals	3	105.61		2.08
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x10	2	10	4	0.08
W8x24	8	24	6.5	1.25
W12x16	1	16	21	0.34
W12x26	4	26	11	1.14
W18x35	1	35	27	0.95
W24x84	1	84	32	2.69
C 4x5.4	8	5.4	4.5	0.19
Totals	25	195		6.64

Total Weight of Floor (k)	1956.78
Total Weight of Floor (PSF)	160.39

Seismic Force Resisting System: Fourth Floor				
Approximate Area (SF)			12200	
Floor to Floor Height (ft.)			12	
Walls				
Perimeter (ft.)			555	
Height (ft.)			12	
Unit Weight (PSF)			91	
Weight (k)			606.06	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			366	
Slab				
Thickness (in.)			8	
Unit Weight (PSF)			80	
Weight (k)			976	
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 5x5x1/4"	3	15.58	12	0.56
HSS 6x6x3/8"	6	27.41	12	1.97
HSS 8x8x3/8"	1	37.61	12	0.45
W24x68	2	68	12	1.63
Totals	12	148.6		4.62
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x10	2	10	4	0.08
W8x24	8	24	6.5	1.25
W12x26	4	26	11	1.14
W18x35	1	35	27	0.95
W24x84	1	84	32	2.69
Totals	16	179		6.11

Total Weight of Floor (k)	1958.78
Total Weight of Floor (PSF)	160.56

Seismic Force Resisting System: Fifth Floor				
Approximate Area (SF)			12200	
Floor to Floor Height (ft.)			17.167	
Walls				
Perimeter (ft.)			389	
Height (ft.)			17.167	
Unit Weight (PSF)			91	
Weight (k)			607.68	
Superimposed				
Partitions (PSF)			15	
MEP (PSF)			10	
Finishes (PSF)			5	
Weight (k)			366	
Slab				
Thickness (in.)			8	
Unit Weight (PSF)			80	
Weight (k)			976	
Columns				
Shape	Quantity	Weight (PLF)	Column Height (ft.)	Weight (k)
HSS 5x5x1/4"	3	15.58	17.167	0.80
HSS 6x6x3/8"	6	27.41	17.167	2.82
HSS 8x8x1/4"	29	25.79	17.167	12.84
HSS 8x8x3/8"	1	37.61	17.167	0.65
W24x68	2	68	17.167	2.33
Totals	41	174.39		19.45
Beams				
Shape	Quantity	Weight (PLF)	Beam Length (ft.)	Weight (k)
W8x18	2	18	10	0.36
W8x31	2	31	9.5	0.59
W12x26	5	26	15.5	2.02
W14x22	13	22	18	5.15
W16x36	1	36	28	1.01
W18x35	1	35	3	0.11
C 8x11.5	28	11.5	6	1.93
Totals	52	179.5		11.16
Roof Joists				
Unit Weight (PLF)			5	
Weight (k)			5.75	

Total Weight of Floor (k)	1986.04
Total Weight of Floor (PSF)	162.79

Seismic Force Resisting System: Roof	
Approximate Area (SF)	11500
Superimposed	
Roof Mat (PSF)	10
MEP (PSF)	10
Weight (k)	230

Total Weight of Floor (k)	230.00
Total Weight of Floor (PSF)	20.00

SEISMIC LOADS

- SITE CLASS D - SOFT SOIL PROFILE
- OCCUPANCY II • IMPORTANT FACTOR 1.0
- SPECTRAL RESPONSE ACCELERATION, SHORT - $S_s = 0.098$
- SPECTRAL RESPONSE ACCELERATION, 1s - $S_1 = 0.045$
- SITE COEFFICIENTS: $F_a = 1.6$ AND $F_v = 2.4$
- $S_{ms} = F_a S_s = (1.6)(0.098) = 0.1568$
- $S_{m1} = F_v S_1 = (2.4)(0.045) = 0.1080$
- $S_{ds} = \frac{2}{3} S_{ms} = \frac{2}{3} (0.1568) = 0.1045$
- $S_{d1} = \frac{2}{3} S_{m1} = \frac{2}{3} (0.1080) = 0.0720$
- $T_a = C_a h_n^x = 0.02 (67.167)^{0.75} = 0.469 \text{ s}$
- $C_u = 1.7$
- $T = T_a C_u = 0.469 (1.7) = 0.797 \text{ s}$
- $C_s = \begin{cases} \frac{S_{d1}}{T(R/I)} = \frac{0.072}{(0.797)(2/1)} = 0.0452 \geq 0.01 \Rightarrow \text{USE THIS VALUE} \\ \frac{S_{ds}}{(R/I)} = \frac{0.1045}{(2/1)} = 0.05225 \geq 0.01 \Rightarrow \text{USE THIS VALUE} \\ \text{MIN } \frac{S_{d1} T_L}{T^2 (R/I)} = \frac{(0.072)(12)}{(0.797)^2 (2/1)} = 0.680 \geq 0.01 \end{cases}$
- $k = \frac{(0.797 - 0.5)(2 - 1)}{(2.5 - 0.5)} + (1) = 1.1485$ [LINEAR INTERPOLATION
SINCE THE PERIOD IS
BETWEEN 0.5 AND 2.5]

SEISMIC LOADS CONTINUED

FLOOR	FLOOR AREA	PERIMETER	TOTAL WEIGHT
FIRST	12,235	570	177.26 PSF
SECOND	12,200	555	160.42 PSF
THIRD	12,200	555	160.39 PSF
FOURTH	12,200	555	160.56 PSF
FIFTH	12,200	389	162.79 PSF
ROOF	11,500	389	20 PSF

• TOTAL BUILDING WEIGHT

$$\text{WEIGHT} = (12,235)(177.26) + (12,200)(160.42) + (12,200)(160.39) + (12,200)(160.56) + (12,200)(162.79) + (11,500)(20)$$

$$\text{WEIGHT} = \boxed{10258 \text{ K}}$$

• BASE SHEAR

$$V = C_s(\text{WEIGHT}) = 0.0452(10258) = \boxed{463.7 \text{ K}}$$

• $w_x h_x^k \Rightarrow$ VARIES DEPENDING ON LEVEL

$$\text{① LEVEL 3: } w_3 = 1956.8, h_3 = 26', k = 1.1485$$

$$w_3 h_3^k = (1956.8)(26)^{1.1485} = \boxed{82534 \text{ Ft-K}}$$

$$\begin{aligned} \sum w_x h_x^k &= 40546 + 82534 + 127755 + 177523 + 28871 \\ &= \boxed{457229 \text{ Ft-K}} \end{aligned}$$

• $C_{vx} = \frac{w_x h_x^k}{\sum w_x h_x^k} \Rightarrow$ VALUES DEPENDING ON LEVEL

$$\text{① LEVEL 3: } C_{vx} = \frac{82534}{457229} = \boxed{0.18}$$

$$F_x = C_{vx}(V)$$

$$\text{① LEVEL 3: } F_x = (0.18)(463.7) = \boxed{83.7 \text{ K}}$$

• STORY SHEAR: $V_x = F_x(\text{① LEVEL}) + F_x(\text{② ALL LEVELS ABOVE})$

$$\text{① LEVEL 5: } V_x = F_x(\text{LEVEL 5}) + F_x(\text{ROOF})$$

$$= 180.04 + 29.28 = \boxed{209.31 \text{ K}}$$

SEISMIC LOADS (CONTINUED)

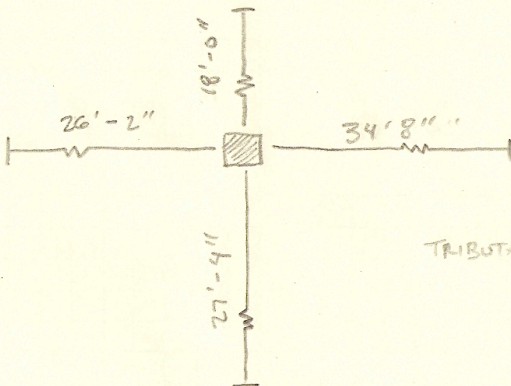
MOMENTS :

$$M_x = (\text{TRIBUTARY FLOOR AREA HEIGHT}) (F_x)$$

$$(a) \text{ LEVEL 5: } \left[\frac{(50 + 38)}{2} \right] (180.04) = \boxed{7921.7 \text{ Ft-K}}$$

Appendix E: Spot Checks

INTERIOR COLUMN SPOT CHECK



- COLUMN ON FIRST FLOOR IN SOUTH EASTERN CORNER
- CHECK IS BASED ON AXIAL GRAVITY LOADS ONLY

$$\text{TRIBUTARY AREA} = \left(\frac{26.167 + 34.667}{2} \right) \cdot \left(\frac{18.0 + 27.33}{2} \right)$$

$$= 689 \text{ ft}^2$$

LIVE LOADS: HOTEL ROOMS = 40 PSF
LOBBY = 100 PSF
PARTITIONS = 15 PSF
ROOF = 20 PSF

LIVE LOAD ELEMENT FACTOR
 $K_{LL} = 4$ (FOR COLUMNS)

LIVE LOAD REDUCTION

$$K_{LL} A_T \geq 400 \text{ ft}^2 \Rightarrow L = L_o \left(0.25 + \frac{15}{\sqrt{K_{LL} A_T}} \right)$$

$$L = L_o \left(0.25 + \frac{15}{\sqrt{(4)(689)}} \right) = L_o (0.536)$$

REDUCED HOTEL LIVE LOAD

$$L = L_o (0.536) = 40 (0.536) = 21.44 \text{ PSF}$$

REDUCED PARTITION LIVE LOAD

$$L = L_o (0.536) = 15 (0.536) = 8.04 \text{ PSF}$$

REDUCED ROOF LIVE LOAD

$$L = L_o (0.536) = 20 (0.536) = 10.72 \text{ PSF}$$

DEAD LOADS: HOTEL ROOMS
ROOF
SUPERIMPOSED DEAD LOADS
WALLS
FLOOR

* VALUES COME FROM SEISMIC ANALYSIS OF FLOOR WEIGHTS

INTERNAL COLUMN SPOT CHECK (CONTINUED)

- LOAD COMBINATION

$$1.2D + 1.6L$$

- FOR THE COLUMN ON THE FIRST FLOOR SUPPORTS LEVELS 2 - ROOF

$$P_U = 947.7$$

- AVAILABLE COLUMN STRENGTH

$$HSS 12 \times 12 \times 5/8''$$

$$\text{BRACED LENGTH OF } 14'$$

$$\text{UNBRACED LENGTH OF } 27'-4''$$

$$L = 27.33'$$

$$K_{L_{EFF}} = L / (r_x / r_y) \quad \text{WHERE} \quad r_x = r_y = 4.62$$

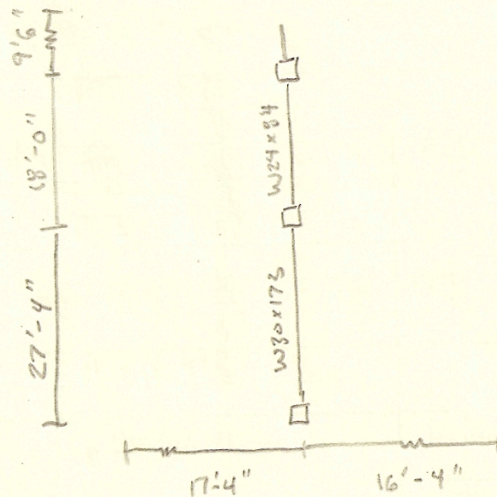
$$= 27.33 / 1 = 27.33 \text{ FT}$$

INTERPOLATE BETWEEN $KL = 27'$ AND $KL = 28'$

$$\phi P_N = 757^k < P_U = 947.7^k$$

NO GOOD, HOWEVER THE ASSUMPTIONS MADE DURING THIS ANALYSIS COULD HAVE ALTERED THE RESULTS AND CAUSED FOR A MUCH HIGHER ULTIMATE LOAD THEN THERE TRULY IS OR CALCULATED A LARGER UNBRACED LENGTH THEN THERE ACTUALLY IS.

INTERIOR BEAM SPOT CHECK



• BEAM ON FIRST FLOOR

• W24x84

LOADS: LIVE: HOTEL ROOMS (40 PSF)
 PARTITIONS (15 PSF)

TOTAL = 55 PSF

DEAD: PRECAST FLOOR (80 PSF)
 SUPERIMPOSED (10 PSF)
 FINISHES (5 PSF)

TOTAL = 95 PSF

$$L = L_0 \left(0.25 + \frac{15}{\sqrt{K_{LL} A_T}} \right) \quad \text{WHERE } K_{LL} = 2 \quad \text{AND } A_T = 18 \left(\frac{27.33 + 16.33}{2} \right)$$

$$A_T = 393 \text{ ft}^2$$

$$L = 55 \left(0.25 + \frac{15}{\sqrt{2(393)}} \right) = 43.18 \text{ PSF}$$

• LOAD COMBINATION

$$1.2D + 1.6L = 1.2(95) + 1.6(43.18) = 183 \text{ PSF}$$

$$\text{TRIBUTARY WIDTH} = \frac{27.33 + 16.33}{2} = 21.83 \text{ ft}$$

$$W_U = 183(21.83) = 3.99 \text{ KLF}$$

$$M_U = \frac{W_U l^2}{8} = \frac{3.99(18)^2}{8} = 161.6 \text{ ft-K}$$

$$b_{\text{eff}} = \left| \begin{array}{l} 21.83(12) = 262'' \\ \text{MIN} \end{array} \right.$$

$$\frac{\text{SPAN}}{4} = \frac{18(12)}{4} = 54'' \Rightarrow \text{USE THIS ONE}$$

INTERNAL BEAM SPOT CHECK (CONTINUED)

• CHECK DEFLECTION UNDER CONSTRUCTION LOADS

$$\Delta_{\text{CONST}} = \frac{5w_{\text{CON}}l^4}{384EI} \quad \text{WHERE } w_{\text{CON}} = 80 \text{ PSF} (21.83) = 1.75 \text{ KLF}$$

$$\Delta_{\text{ALLOW}} = \frac{l}{360} = \frac{18(12)}{360} = 0.6''$$

$$I_{\text{REQUIRED}} = \frac{5w_{\text{CON}}l^4}{384\Delta_{\text{CON}}E} = \frac{5(1.75)(18)^4(1778)}{384(0.6)(29000)} = 244.4 \text{ in}^4$$

$$I_x \text{ OF } W24 \times 84 = 2370 \gg 244.4 \therefore \text{OK}$$

• CHECK BENDING FOR CONSTRUCTION

$$w_{\text{CON}} = 1.75 \text{ KLF} \quad w_{\text{WLF}} = 20(21.83) = 0.437 \text{ KLF}$$

$$w_0 = 1.2(1.75) + 1.6(0.437) = 2.8 \text{ KLF}$$

$$M_0 = \frac{w_0 l^2}{8} = \frac{2.8(18)^2}{8} = 113.4 \text{ Ft-k}$$

$$\phi M_N \text{ OF } W24 \times 84 = 840 \gg 113.4 \therefore \text{OK}$$

• AVAILABLE STRENGTH IN FLEXURE

$$\text{ASSUME } \Sigma Q_N = 1240 \Rightarrow a = \frac{\Sigma Q_N}{0.85(F'_c)(b_{\text{eff}})} = \frac{1240}{(0.85)(4)(54)} = 6.75$$

$$Y_2 = 10' - a/2 = 10 - 6.75/2$$

$$Y_2 = 6.6'' \text{ (ROUND DOWN TO 6'')}$$

$$W24 \times 84, Y_2 = 6, \Sigma Q_N = 1240 \quad \text{PNA @ TFL}$$

$$\phi M_N = 1670 \gg 161.6 = M_0 \therefore \text{OK}$$

• DEFLECTION

$$Y_2 = 6 \Rightarrow I_b = 6400 \quad w_{\text{WLF}} = (43.18)(21.83) = 0.943 \text{ KLF}$$

$$\Delta_{\text{ALLOW}} = \frac{l}{360} = \frac{18(12)}{360} = 0.6''$$

$$\Delta_{\text{LL}} = \frac{5w_{\text{LL}}l^4}{384EI_b} = \frac{5(0.943)(18)^4(1778)}{384(29000)(6400)}$$

$$\Delta_{\text{LL}} = 0.012'' < 0.6'' \text{ ALLOW} \therefore \text{OK}$$

PRECAST CONCRETE FLOOR SPOT CHECK

• FOR TYPICAL FLOORS w/ MAX SPAN = 30'-2"

LIVE LOAD = 40 PSF

DEAD LOAD: PARTITIONS = 15 PSF
MEP = 10 PSF
FINISHES = 5 PSF
TOTAL DEAD = 30 PSF

LOAD COMBINATIONS:

$$1.2 D + 1.6 L = 1.2(30) + 1.6(40) = 100 \text{ PSF}$$

IN ORDER TO COMPLETE THE CHECK, THE MANUFACTURER OF THE PRECAST PLANK WOULD HAVE TO PROVIDE TECHNICAL SPECIFICATIONS ON THE 8" PRECAST PLANK SPANNING A DISTANCE OF 30'-2". THESE SPECIFICATIONS WOULD HAVE TO PROVE THAT THE PLANKS ARE DESIGNED TO HOLD LOADS OF AT LEAST 100 PSF IF NOT GREATER.