ALCOA

BUSINESS SERVICES CENTER

30 ISABELLA STREET PITTSBURGH, PA

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STRUCTURAL TECHNICAL REPORT 1
STRUCTURAL CONCEPTS/STRUCTURAL EXISTING CONDITIONS REPORT

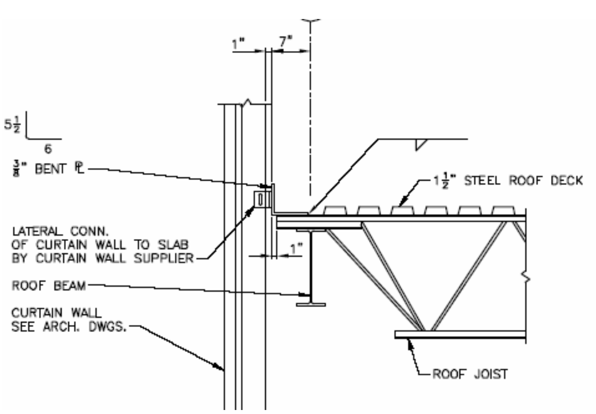
- OVERALL STRUCTURAL SYSTEM
- CODES
- MATERIAL PROPERTIES
- LOADS
- MEMBER CHECK
- FURTHER INVESTIGATIONS

Overall Structural System:

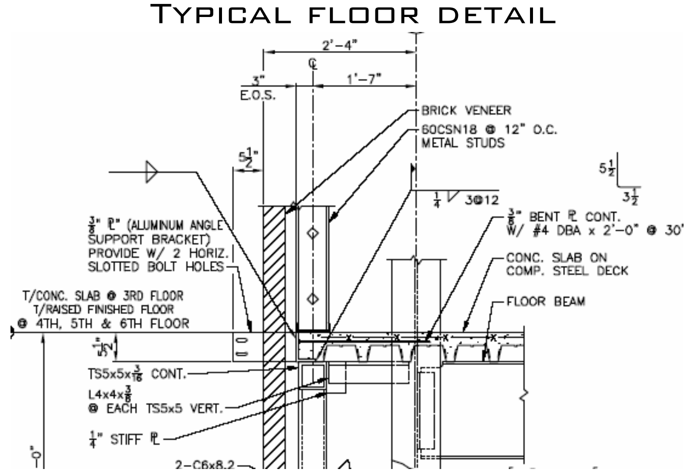
Gravity Framing:

The Alcoa Business Services Center is a composite steel and concrete system. Each floor makes use of composite design by combining light weight concrete with composite decking and shear studs. The typical floor thickness of 5 ½" concrete gives the floor its required 2 hour fire rating while maintaining its structural integrity. All beams, girders, and columns are typical W shape 50ksi steel. The Alcoa building was design with a composite system to help decrease the weight of the building while allowing for large spans of 30 feet for an open office space. Being that the building is built on the Riverfront in downtown Pittsburgh, Pennsylvania; the engineers had problems getting the proper soil capacity. The alluvial soil deposits from the river required the building to be built on deep foundations, which is best complimented with a lighter building. Therefore a concrete system was not designed. The roof system of the Alcoa building is a combination composite and joist construction. The mechanical loads located near the inner core of the building required a composite floor system, but outside the mechanical equipment the roof consists of metal decking on a joist, beam system. Moment connections exist around the perimeter of the building to help fasten the curtain wall system to the frame of the building.

Typical roof detail

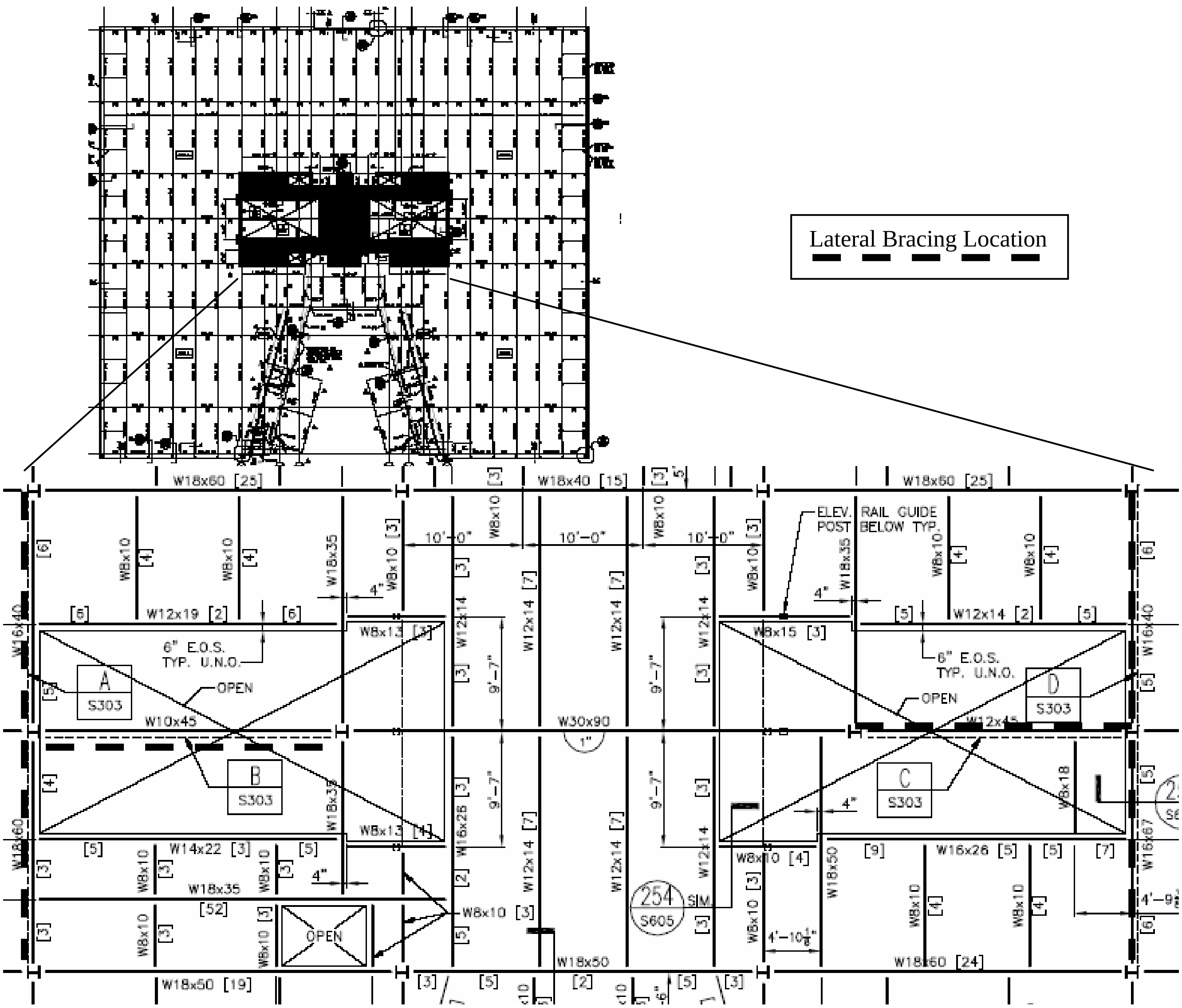


Typical floor detail



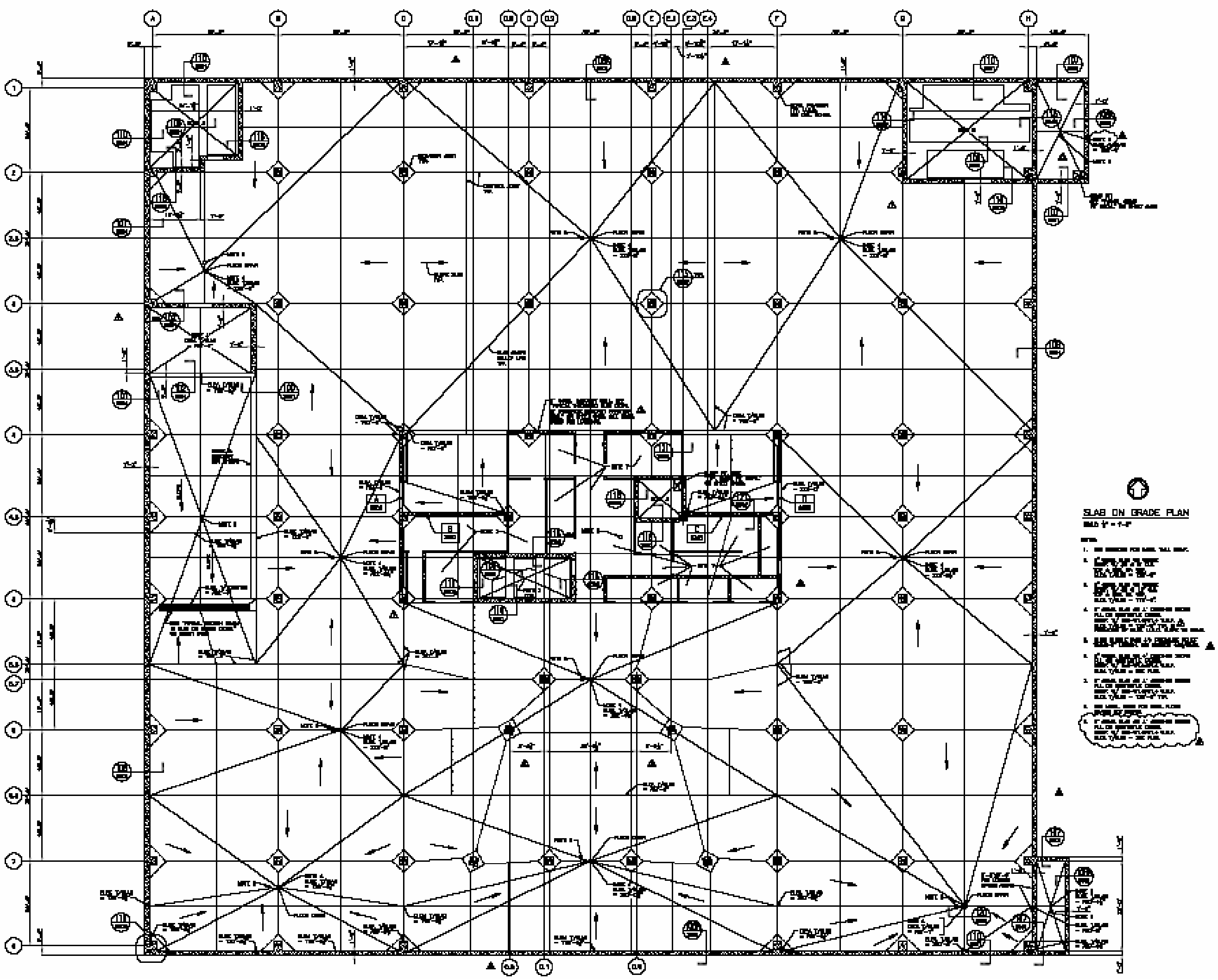
LATERAL FRAMING:

A DIAGONAL CROSS BRACING SYSTEM RESISTS THE LATERAL FORCES PRESENT ON THE ALCOA BUILDING. THE CONCENTRIC BRACING IS PRESENT BOTH WAYS IN THE FRAME OF THE BUILDING. THE BRACING RESISTS BOTH NORTH-SOUTH AND EAST-WEST WIND LOADS ON THE BUILDING. IN ORDER TO KEEP THE DIAGONAL BRACING FROM OBSTRUCTING THE BAYS OF THE BUILDING IT IS LOCATED IN THE INNER CORE OF THE BUILDING.



Foundation System:

The foundation system consists of auger cast piles and grade beams. The poor soil condition present on the site of the Alcoa Business Services Center required a deep foundation. The soil was characterized by USDA standards as yellowish brown silty sand. The piles are an average of 50' deep and rest on siltstone bedrock. Each pile has an allowable End bearing capacity of 68 tons per square foot as well as a 11.45 and 9.5 ton uplift and lateral capacity respectively. The foundation system also makes use of concrete grade beams. A typical grade beam used in the building varies between 24 and 26 inches by 36 inches deep. For the basement parking garage a concrete wall bears on the grade beams below which is used to carry the masonry units above grade.



Codes:

- Boca 96
- Aisc 1989
- Aci 301/318 1989

Material Properties:

Steel:

- Structural Shapes: astm a992 Typical 50ksi steel
- Steel Tubes: astm 500, grade b
- Steel Pipe: astm 500, grade b
- Galvanized Structural steel:
  - Shapes and Rods: astm a123
  - Bolts, Fasteners, & Hardware: astm a153
- Bolts: Typical astm a325 ¾" Diameter
- Shear Studs: astm a108, grade 1015 or 1020
  - Typical ¾" diameter by 5" deep

Concrete: (F'c required at 28 days)

- Foundation: 4000 psi (Normal Weight 145 pcf)
- Interior Slabs: 4000 psi (Light weight 110 pcf)
- Exterior Slabs: 4000 psi (Normal Weight 145 pcf)
- Grout:
  - Masonry (astm c476) 3000 psi min
  - Leveling 5000 psi min
- Reinforcing: 60 ksi steel

LOADS:

DEAD LOADS:

THE BASIC DEAD LOADS CALCULATED FOR THE ALCOA BUSINESS SERVICES CENTER ARE LISTED BELOW AS WELL AS THE WEIGHT OF EACH FLOOR. A CALCULATED MECHANICAL LOAD WAS ADDED TO THE ROOF BECAUSE FOUR AIR CONDITIONS ARE LOCATED ON THE COMPOSITE FLOOR WITH AN OPERATING WEIGHT OF 33,750 POUNDS EACH.

Dead Load		
		Load
Typical Floor		(psf)
	Concrete on Metal Deck	32
	Steel Self-Weight	8
	Partitions	20
	Ceiling/Mechanical	7
	Raised Floor System (Floors 4-6)	10
	Total	**77**
Roof		
	EPDM/Insulation/metal deck	20
	Concrete on Metal Deck (Composite)	32
	Steel Self-Weight (Composite)	8
	Steel Self-Weight (joist section)	7
	Superimposed	25
	Mechanical General	7
	Mechanical (Air Conditioners)	135 Kips
	Total EPDM Roof	**59**
	Total Composite Roof	**72**
Exterior Wall		
	Total	**17**
Snow Load		
	Total (80% reduction of 30psf)	**6**

Floor Dead Loads		Sq. ft.	W (kips)	Wall Height	W (kips)walls	Snow Load	Total W
	LEVEL					(kips)	(kips)
	Basement (SOG)	45792		11			
	1st Floor	42192	2826.9	19.0	276.5		3103.4
	2nd Floor	40892	3148.7	14.0	203.7		3352.4
	3rd Floor	41692	3210.3	14.0	203.7		3414.0
	4th Floor	41692	3210.3	14.0	203.7		3414.0
	5th Floor	42292	3256.5	14.0	203.7		3460.2
	6th Floor	42292	3256.5	15.3	223.1		3479.6
	Roof	42292	2790	12.2	53.9	179	3022.9
	Penthouse 1	3600	187.2	11.3	36.9	74	298.1
	Penthouse 2	560	29.12			8	37.1
		Sum					**23581.7**

Live Load:

The live loads of the Alcoa Business Services Center were recorded from both BOCA 96 and the actual design notes of the building. It is noted that BOCA is the minimum and in many instances the design team choose to exceed the minimum requirements. For instance on the office floor instead of 50 psf, the floors are design at 60 psf. This is most likely because of the raised floor system required to accommodate Alcoa's needs. Many of the live loads on the roof are controlled by heavy storage and mechanical loads. Because the first floor is retail space the floor was required to be designed at 100psf. The basement is also designed to match the vehicle driveway because it serves as a parking garage.

Floor/Roof Live Loads				
		Boca Minimum Requirement		Actual Design
Typical Floor		(psf)		(psf)
	1st Floor	100		100
	Office Levels (2-6)	50		60
	Corridors (>1st floor)	80		80
	Balconies/Stairs	100		100
	Sidewalk/Vehicle Driveway	250		250
	Storage Areas (Heavy)	250		250
	Mechanical Rooms	125		125
Roof				
	Snow	25		30

SNOW LOAD-

THE GROUND SNOW LOAD FOR THE SITE LOCATION IN PITTSBURGH IS 30PSF. IT IS NECESSARY TO LOOK AT SNOW DRIFTING DUE TO THE PENTHOUSES ON THE TOP OF THE BUILDING. THE MAXIMUM LOAD DUE TO SNOW DRIFTING IS 56.2 PSF. BELOW ARE THE STEPS BOCA 96 USES TO EVALUATE SNOW.

Snow Load			Value
	Ground Snow Load	Pg	30psf
	Snow Exposure Factor	Ce	0.6
	Snow Importance Factor	Is	1
	Height from Low to High Roof	Hr	24'

FLAT ROOF SNOW LOAD:

$P_f = (C_e * I * P_g)$

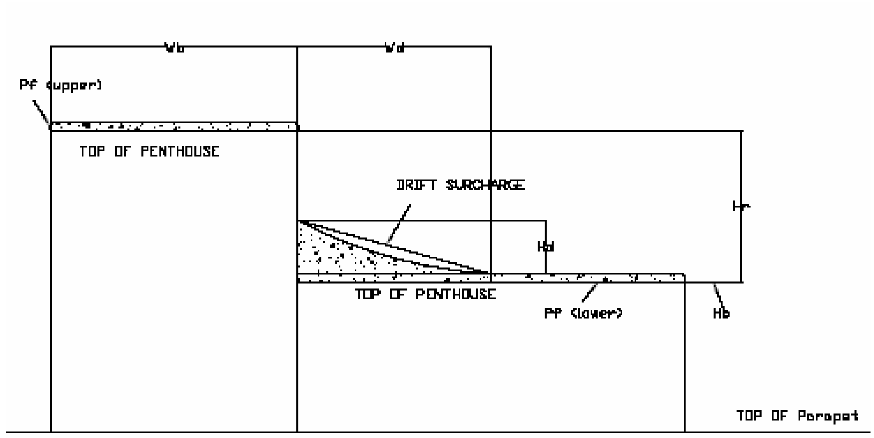
$P_f = (25 * 1 * 0.6) = 15$psf

UNBALANCED SNOW LOAD ON LOW ROOF:

$P_f = (C_e * I * P_g)$
$P_f = (25 * 1 * 0.6) = 15$psf

$D = (0.13 * P_g) + 14$
$D = (0.13 * 30) + 14 = 17.9$ pcf

H_d=2.3' (From Boca 96 fig 1608.7)
H_b=Pf/D = 15/17.9 = .84' = 10"
$H_d + H_b = 3.14$'



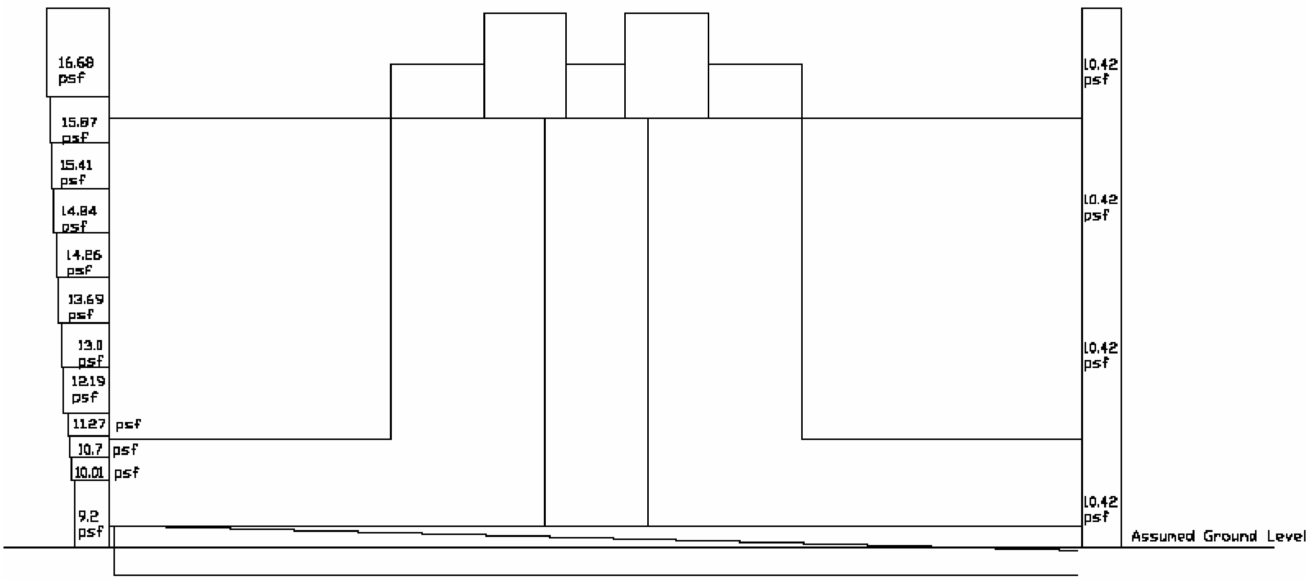
$(H_r - H_b)/ H_b = (24'-.84')/.84' = 27.6 > 0.2$; Consider Drift

$P_m = D(H_b+H_d) = 17.9(3.14) = 56.2$ psf

$W_d = 4(H_r - H_b) = 4(24'-.84') = 92.64'$
$W_d = 4(H_d) = 4(2.3) = 9.2'$

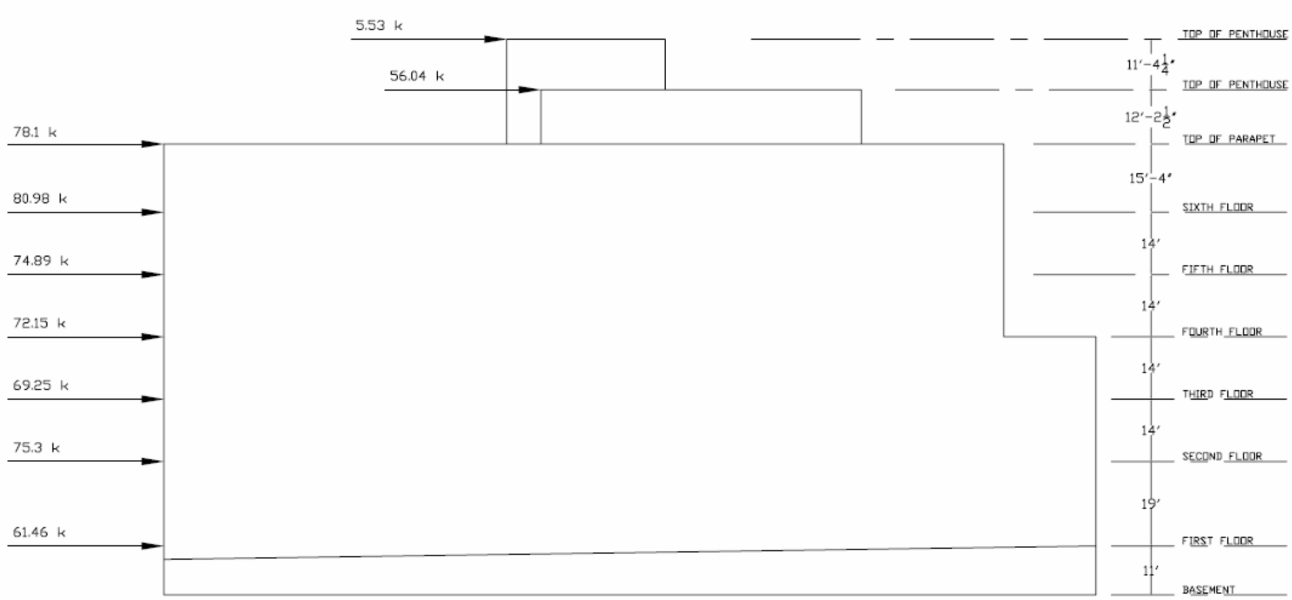
Wind Load-

The wind load is the controlling lateral load on the Alcoa building. The lateral bracing system was concentrically braced framing. The building was examined with the wind blowing North-South and East-West. The factors are listed below as well as the diagrams. Refer to the appendix for calculations.



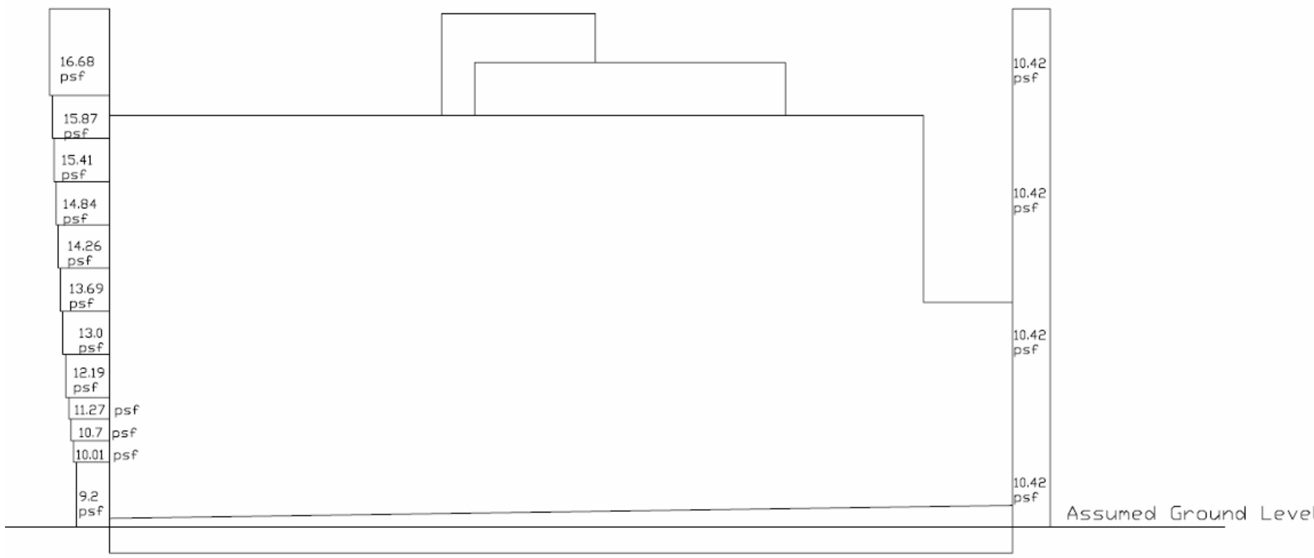
Wind Pressures

NORTH ELEVATION



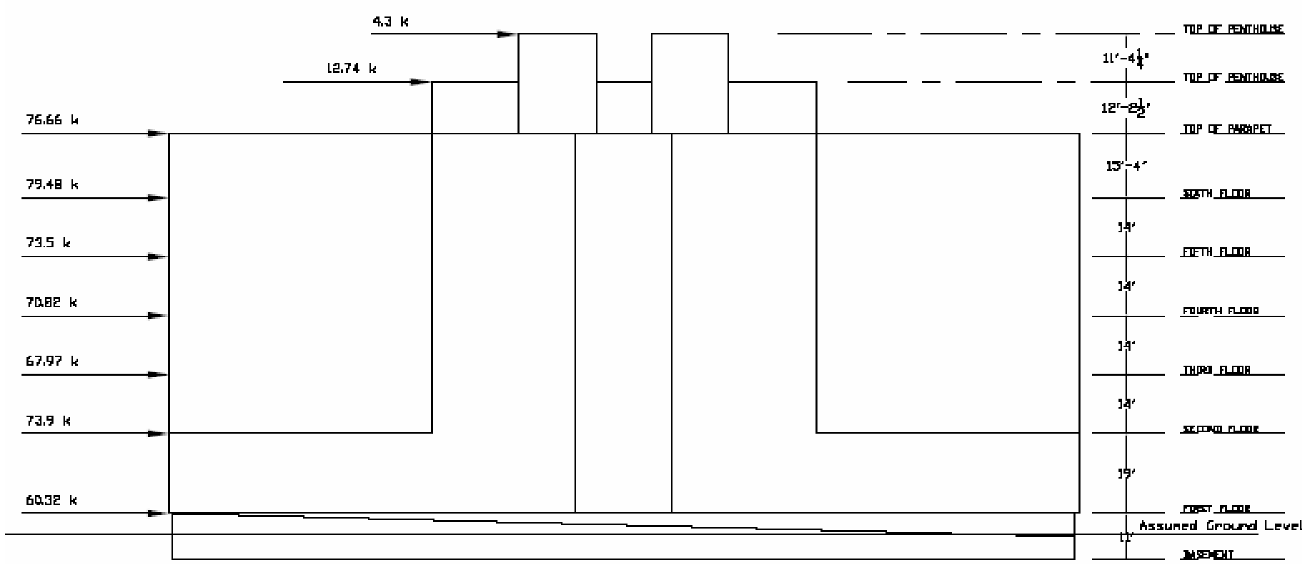
Wind Forces North-South

EAST ELEVATION



Wind Pressures

EAST ELEVATION

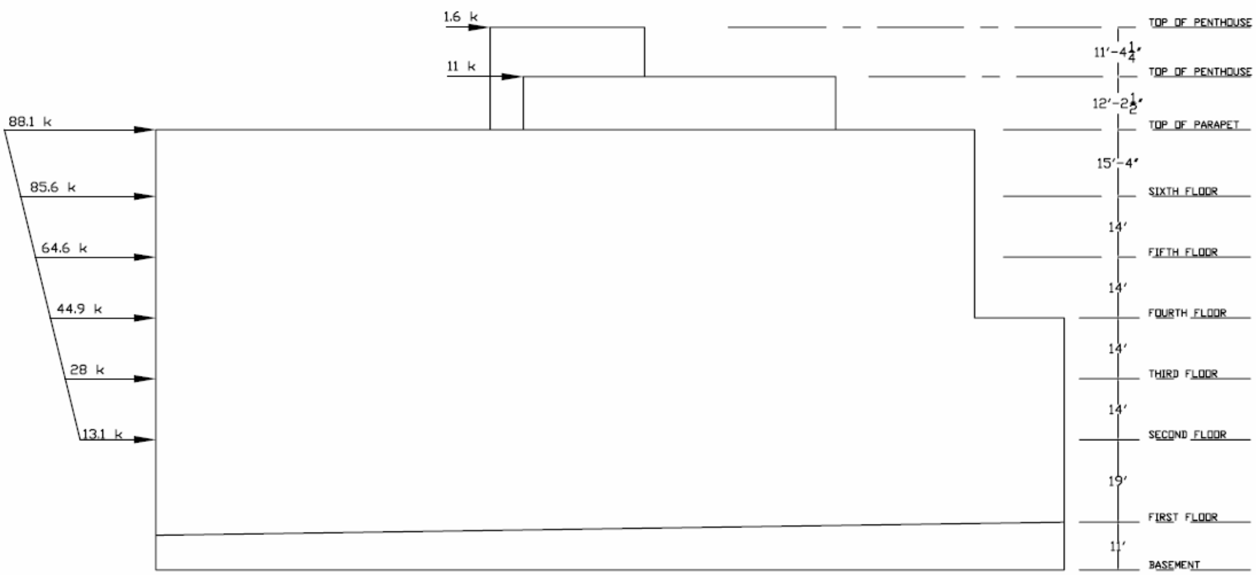


Wind Forces East-West

NORTH ELEVATION

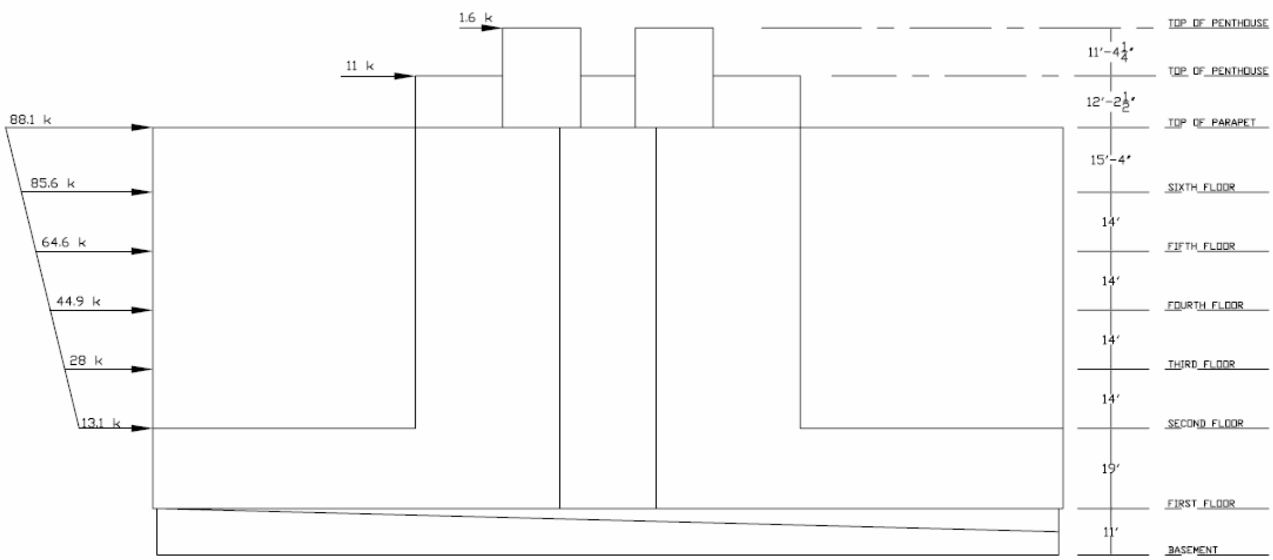
Seismic Load-

Boca 96 does not require seismic analysis for buildings with ground acceleration less then .05. Pittsburgh, Pennsylvania falls in the .05 or less category. The reason for not having to check seismic is that wind will always control. I ran the seismic analysis just to see how close the numbers would be end up being. The soil of the site is very poor, so I assumed that we have a S3 soil type. The results are shown in the diagrams below.



Seismic Forces

EAST ELEVATION



Seismic Forces

NORTH ELEVATION

Lateral Load Comparison-

Below are the results of the lateral load analysis summarized to allow for easy comparison. As you can see, the wind load controls the building's lateral forces.

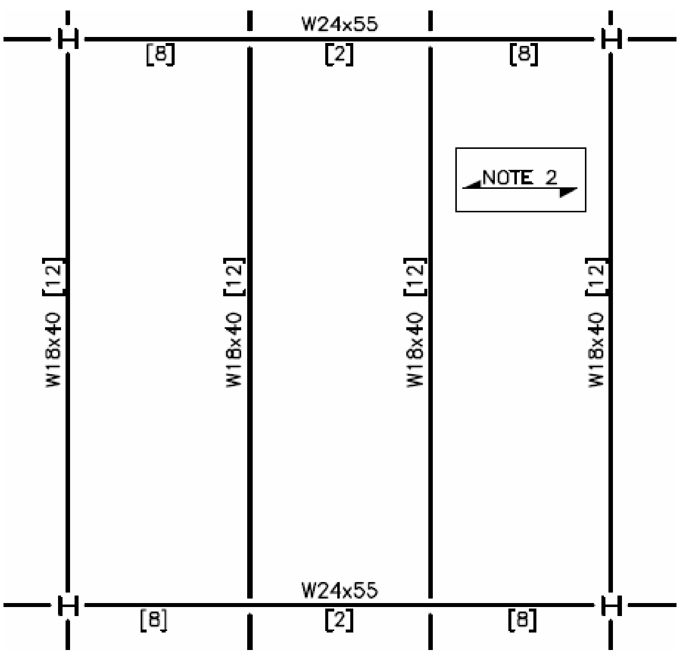
Lateral Load Comparison

	North-South		East-West	
Level				
	Seismic	Wind	Seismic	Wind
Basement	0.0	0	0	0
1	0.0	**61.46**	0	**60.32**
2	13.1	**75.3**	13.1	**73.9**
3	28.0	**69.25**	28	**67.97**
4	44.9	**72.15**	44.9	**70.82**
5	64.6	**74.89**	64.6	**73.5**
6	**85.6**	80.98	**85.6**	79.48
Roof	**88.1**	78.1	**88.1**	76.66
Penthouse 1	11.0	**56.04**	11	**12.74**
Penthouse 2	1.6	**5.53**	1.6	**4.3**
SUM	336.9	**573.7**	336.9	**519.69**

Member check-

Typical Floor framing-

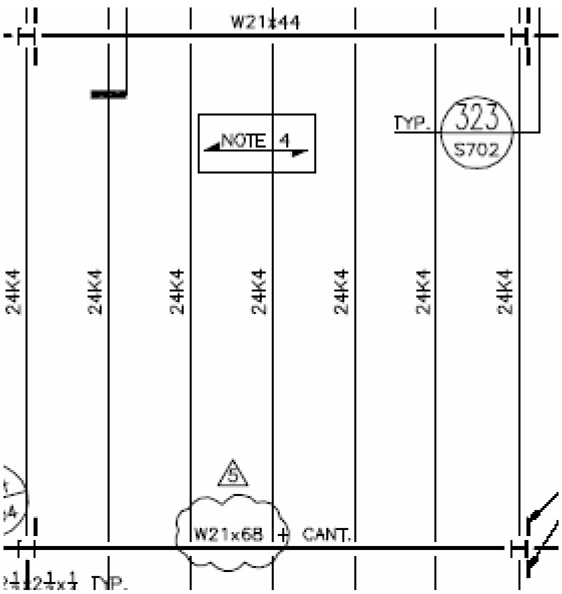
The Alcoa building's framing is basically consistent throughout the building. A typical bay is about 32' by 30' feet with 5 1/2" of lightweight concrete on metal deck to form a composite system. This frame was taken from the fourth floor of the Alcoa Business Services Center.



Under the loading conditions, explained early in the report, the composite beams check out ok. From the results I got I believe that my dead load is very accurate to what the actual dead loads are on the existing floor. I know what the designers had to use for live loads therefore my results look good. The girder also checked out ok with my loads. I used the beam reactions to gain an accurate loading. The major difference in my calculations of the girder was and additional 10 shear studs.

Typical roof framing-

The Alcoa building's roof framing has two major types of framing. Where the mechanical systems are located we have a composite system and the rest of the roof is a joist/beam construction with 1 ½" metal decking toped with an EPDM roof. Below is a typical framing section of the roof which is 32' by 30'.



When checking the 24k4 joist with Vulcraft's product catalog, I found that the 24k4 doesn't work at the 32' span it is currently designed to handle. The reason I believe this occurred is because I added 25 psf superimposed load on the roof. This was done to compensate for vents, ballasts, and other issues I did not have information enough to formulate a better result. The 24k4 would work at a 28' span with the loads I have calculated. . The W21x44 beam also failed with the loads applied. I believe that I need to reduce my dead load because the actual moment was 263 k-ft to an allowable of 225 ft-k.

Column Check:

From the typical floor calculations, I checked the column that continues from floor 2 up to floor 4. I used a live load reduction in order to make the W12x65 work with the loads that the building was designed.

Lateral check-

To gain knowledge of the actual loads on the lateral bracing I completed a simplified truss analysis. I assumed that the inner core bracing is acting like a truss to resist all of the wind force placed on the building. The bracing members received 61.38 kips tension or compression according to my calculations. This is lower then the 75 kips T or C designed specified in the drawings. Therefore the lateral system will resist the necessary loads.

Further investigations-

Foundations-

The foundations are subject to hydraulic lift due to water issues on the site. The auger piles have been designed to resist the uplift present but further soil reports and investigations are yet required.

Camber-

Many of the long spanning members of the building are to be designed and fabricated with a camber. The camber is designed to compensate for dead load deflection that will occur over the long spans.

Canopies-

The building has special architectural canopies which will be subject to snow and wind loads.

Curtain wall connections:

Boca requires that the connections that the curtain wall connections resist the lateral forces from the wind load. All connections will have to be designed per the code.

uplift-

The roof of the building will be subjected to uplift due to the added penthouses on the top of the building.