ASCE 41-17 Tier 1 Seismic Evaluation
Building Name: Cogeneration Plant
CAAN ID: 1374
Auxiliary Building ID: 1374.1
Address: 209 Frank Schlessinger Way, Berkeley, CA
Site location coordinates: Latitude 37.87019 Longitudinal -122.26341

Plan Image or Aerial Photo

Exterior Elevation Photo

UCOP *SEISMIC PERFORMANCE LEVEL* (OR "RATING") BASED ON TIER 1 EVALUATION FINDINGS: IV

BUILDING DATA
ASCE 41-17 Model Building Type (Governing Building Type bolded for Seismic Risk Model when multiple types exist):

a. Longitudinal Direction: C2, Concrete Shear Wall – rigid diaphragm
b. Transverse Direction: C2, Concrete Shear Wall – rigid diaphragm

Square Footage: 12,172 SF (out of 20,385 SF total for the combined buildings)
Building Length: 141' (east-west direction)
Building Width: 54' (north-south direction)
Building Height: 34' (to top of parapet)
Story Height: 24' (to top of roof)
Number of stories *above* grade: 2 (*includes mezzanine levels)
Number of basement stories *below* grade: 1

Year of Original Construction and Code Year: 1989, 1982 UBC
Year of Later Constuction and Code Year: not applicable

COST RANGE TO RETROFIT (if applicable): N/A

BUILDING DESCRIPTION

General
This building was built in 1989 and is situated on a level site immediately adjacent to the 1930 Central Heating Plant. The building is trapezoidal in plan and houses the turbines plus associated equipment for cogeneration and miscellaneous office/storage space.

A 4" seismic separation joint was incorporated between the Cogeneration and Central Heating Plants. The roof of the Cogeneration Plant is at 23.5' and the roof of the Central Heating Plant is at 43.5'.

Structural System

The gravity load structural system consists of normal-weight concrete on metal decking over steel joists, framing into steel beams. The steel beams frame into either steel columns at one end in the interior, or at the other end are anchored into the concrete walls at the exterior. The ground floor is a reinforced concrete mat slab. The basement is partial and occupies the western portion of the Plant. Basement walls are reinforced concrete, again framing down to a mat slab. Two separate mezzanines are of steel framing with normal-weight concrete on metal decking.

The lateral load system of the overall building consists of reinforced concrete shear walls around the perimeter of the building. The roof slab serves as horizontal diaphragm. The mezzanines are supported by both the reinforced concrete shear walls on the exterior, with braced frames on the interior.

Building Condition

Good.

Date of Site Visit: 11/08/2018, Abe Lynn, Degenkolb Engineers
Limitations of walk-through: none.

SITE INFORMATION

Site Class (A-F): D Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project, which was immediately adjacent to the Cogeneration Plant.
Site Specific Ground Motion Study? Yes, 2015 Update to the Site-Specific Seismic Hazard Analyses and Development of Seismic Design Ground Motions
BSE-1N Spectral Accelerations: Basis: 2015 Site Specific Report Table 5 for 36-75 ft Soil
S_{DS}: 2.40 S_{D1}: 0.71
BSE-2E Spectral Accelerations: Basis: 2015 Site Specific Report Table 6 for 36-75 ft Soil
S_{XS}: 3.15 S_{X1}: 1.05
Level of Seismicity: High
Performance Level: Collapse Prevention Structural Performance

Geologic Hazards:
Fault Rupture No Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/
Liquefaction Low Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/
Landslide Low Basis: 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project and CGS website https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/

PREVIOUS RATINGS SUMMARY

1. N/A

DOCUMENTATION

Architectural, Civil and Mechanical ("A and C") Drawings: Cogeneration Plant, Impell Corporation, April 24, 1986, Sheet Numbers (AE Numbers) A1 – A8 of architectural set. C-1 to C-23 of civil set, and M-SK-002 to M-SK-405 of mechanical set.

Structural Drawings: Cogeneration Plant, Impell Corporation, June 30, 1986, Sheet Numbers (AE Numbers) S1 – S131 of structural set.

Seismic Evaluations: N/A

Geotechnical Reports: Not available for original construction; however, 2012 Geotechnical Engineering Study by Geosphere Consultants, Inc. of the Evans Diamond Sports Lighting and Scoreboard Project which was immediately adjacent to the Cogeneration Plant.

Other Documents: None

CONSTRUCTION DATA

Gravity Load Structural System:	normal-weight concrete on metal decking on steel joists framing into steel beams. The steel beams frame into either steel columns in the interior, or are embedded in the concrete walls at the exterior.		
Exterior Transverse Walls:	Reinforced concrete	Opening(s)?	No
Exterior Longitudinal Walls:	Reinforced concrete	Opening(s)?	Yes, one side
Roof Materials/Framing:	3 1/2" reinforced concrete (normal weight) slabs on 3" metal deck over steel joists framing into steel beams.		
Intermediate Floors/Framing:	Mezzanine levels over partial floor plan (gravity framing same as roof)		
Ground Floor:	3'-6" thick concrete mat foundation		
Columns:	W6x15, W10x45 and W10x60 Interior Steel Columns	Foundation:	Mat foundation
General Condition of Structure:	Good		
Evidence of Settling?:	No		
Special Features & Comments:	Mezzanines are supported by concentrically-braced frames with one mezzanine using a brace using "vertical slotted holes" at one end. While it is likely that the vertical slotted holes would prevent gravity load from being distributed to the braces, it is unclear how lateral load could be resisted without developing a vertical component in the braces.		

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
ASCE 41-17 Building Type:	C2: Concrete SW	C2: Concrete SW
Diaphragms:	Composite deck on steel joists and beams	Composite deck on steel joists and beams

Vertical Elements:	Wide Flange columns in interior	Wide Flange columns in interior
Connections:	Mezzanine steel braces are welded, beam-to-column connections are bolted.	Mezzanine steel braces are welded, beam-to-column connections are bolted.
Details:	Ex: Exterior Connection Detail 4/Sheet S-119	Ex: Exterior Connection Detail 4/Sheet S-119
Estimated Fundamental Period, T (sec):	0.28	0.28
BSE-2E Spectral Acceleration, S_a:	3.15g	3.15g
Modification Factor, C:	1.4 (C2 – Table 4-7)	1.4 (C2 – Table 4-7)
Building Weight, W (kips):	1669	1669
Seismic Base Shear, V (kips):	7361	7361
System Modification Factor, M_s:	4.5 for reinforced concrete shear wall at CP per Table 4-8 of ASCE 41-17	4.5 for reinforced concrete shear wall at CP per Table 4-8 of ASCE 41-17

Significant Structural Deficiencies, Potentially Affecting *Seismic Performance Level* Designation:

☐ Lateral System Stress Check (wall shear, column shear or flexure, or brace axial as applicable)

☐Load Path

☐Adjacent Buildings

☐Weak Story

☐Soft Story

☐Geometry (vertical irregularities)

☐Torsion

☐Mass – Vertical Irregularity

☐Cripple Walls

☐Wood Sills (bolting)

☐Diaphragm Continuity

☐Openings at Shear Walls (concrete or masonry)

☐Liquefaction

☐Slope Failure

☐Surface Fault Rupture

☐Masonry or Concrete Wall Anchorage at Flexible Diaphragm

☐URM wall height to thickness ratio

☐URM Parapets or Cornices

☐URM Chimney

☐Heavy Partitions Braced by Ceilings

☐Appendages

OVERALL SEISMIC DEFICIENCIES & EXPECTED SEISMIC PERFORMANCE

Although loosely trapezoidal in plan, the building is fairly regular and symmetric in placement of shear walls. For the majority of the building, there is a clear lateral load path from roof to foundation. Calculated wall shear stresses are 84 psi, below the minimum allowable of 100 psi, or the 110 psi based on the specified concrete strength.

The 4" seismic separation between the Cogeneration Plant and the Central Plant would correspond to a 1.4% total drift between the two buildings in order for contact to occur. The walls of the Cogeneration Plant are strong, both in- and out-of-plane. Both buildings are reinforced concrete shear wall buildings with significant area of wall in each direction.

While there are no identified Tier 1 deficiencies, the braces that support the western-most mezzanine are noted to use "vertical slotted holes" at the upper end. While it is likely that the vertical slotted holes would prevent gravity load from being distributed to the braces, it is unclear how lateral load could be resisted without developing a vertical component in the braces.

Based on the above, the building is assigned a SPL IV rating.

The non-structural equipment was observed to be braced, either to the ground or to the structure. Adequacy of bracing/anchorage was not checked.

Seismic Retrofit Concept Sketches/Description (only if above-listed rating is V or greater):

Not applicable

Appendices

A. Additional Photos

B. ASCE 41-17 Tier 1 Checklists (Structural)

C. UCOP Seismic Safety Policy Falling Hazards Assessment Summary

D. Quick Check Calculations

APPENDIX A

Additional Photos

Figure A.1 East Elevation of the Combined Buildings of the Central Plant (Cogeneration Plant is to left, Central Heating is to right)

Figure A.2 East Elevation of Cogeneration Plant, specifically. Note lack of openings that is common for the east, south and west faces.

Figure A.3 Intersection of Central Heating Plant (at left) and North face of Cogeneration Plant (at right) (note vertical gray line which covers the 4" seismic separation between the buildings)

Figure A.4 West Mezzanine (note concentric brace – vertical slotted bolts can just be seen at top of brace)

Figure A.5 West Mezzanine (note concentric bracing at interior bays)

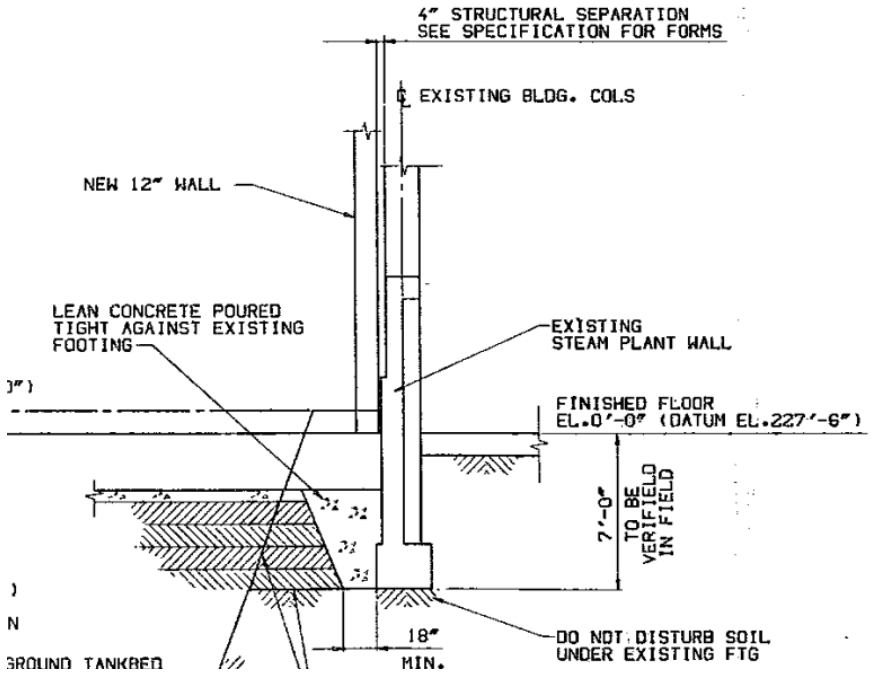

Figure A.6 Section Showing 4" Seismic Separation Between Central Heating Plant and Cogeneration Plant

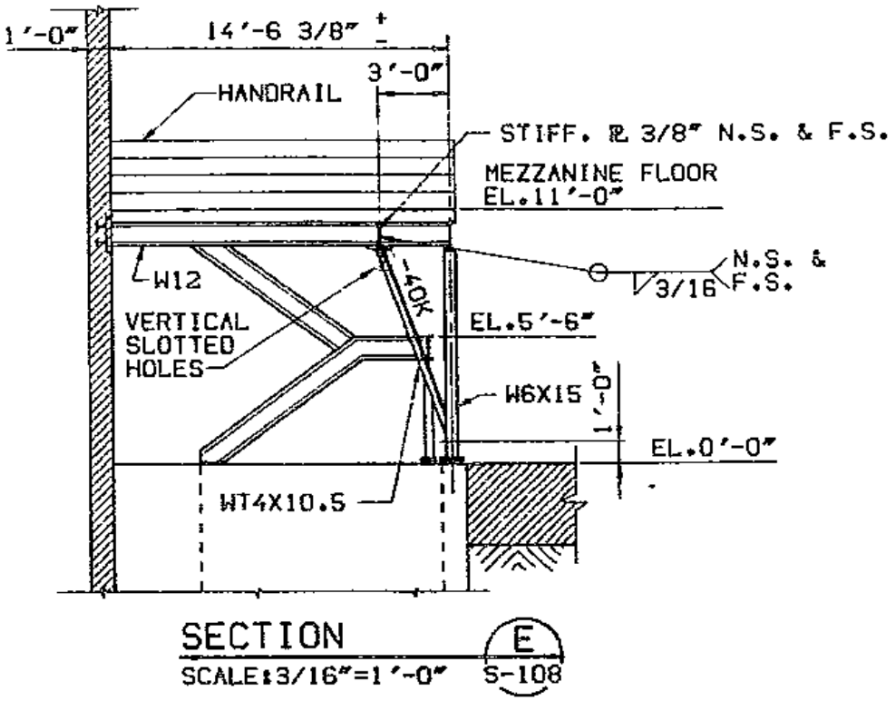

Figure A.7 Section Showing West Mezzanine and Brace. Note "vertical slotted holes" at top of brace.

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	Berkeley			Date:	December 27, 2018		
Building CAAN:	1374	Auxiliary CAAN:		By Firm:	Degenkolb		
Building Name:	1989 Cogeneration Plant			Initials:	ACL	Checked:	
Building Address:	Cross Campus Road			Page:	1	of	3

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C NC N/A U ● ○ ○ ○	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1) **Comments:**
C NC N/A U ● ○ ○ ○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:**
C NC N/A U ● ○ ○ ○	SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the greater of 100 lb/in.^{2} (0.69 MPa) or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** Shear stress calculates out to 70 psi.
C NC N/A U ● ○ ○ ○	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** Wall reinforcement calculates out to a vertical and horizontal steel ratio of 0.0028.

Connections

	Description
C NC N/A U ○ ○ ● ○	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments:**
C NC N/A U ● ○ ○ ○	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2) **Comments:**

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

C	NC	N/A	U	
●	○	○	○	FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation with vertical bars equal in size and spacing to the vertical wall reinforcing directly above the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4) **Comments:**

High Seismicity (Complete The Following Items In Addition To The Items For Low And Moderate Seismicity)

Seismic-Force-Resisting System

				Description
C	NC	N/A	U	
●	○	○	○	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2) **Comments:**
○	○	●	○	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3) **Comments:**
○	○	●	○	COUPLING BEAMS: The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1) **Comments:**

Diaphragms (Stiff Or Flexible)

				Description
C	NC	N/A	U	
●	○	○	○	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments:**
●	○	○	○	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments:**

UC Campus:	Berkeley			Date:	December 21, 2018		
Building CAAN:	1374	Auxiliary CAAN:		By Firm:	Degenkolb		
Building Name:	1989 Central Heating Plant			Initials:	ACL	Checked:	
Building Address:	Cross Campus Road			Page:	3	of	3

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Flexible Diaphragms

C	NC	N/A	U	Description
○	○	●	○	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:**
○	○	●	○	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2) **Comments:**
○	○	●	○	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:**
○	○	●	○	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:**
●	○	○	○	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5) **Comments:**

Connections

C	NC	N/A	U	Description
○	○	●	○	UPLIFT AT PILE CAPS: Pile caps have top reinforcement, and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5) **Comments:**

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	Berkeley			Date:	12/27/2018		
Building CAAN:	1374.1	Auxiliary CAAN:	N/A	By Firm:	Degenkolb Engineers		
Building Name:	1989 Congeneration Plant			Initials:	ACL	Checked:	
Building Address:	209 Frank Schlessinger Way, Berkeley, CA			Page:	1	of	1

UCOP SEISMIC SAFETY POLICY
Falling Hazard Assessment Summary

	Description
P ☐ N/A ☒	**Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)** **Comments:**
P ☐ N/A ☒	**Heavy masonry or stone veneer above exit ways or public access areas** **Comments:**
P ☐ N/A ☒	**Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas** **Comments:**
P ☐ N/A ☒	**Unrestrained hazardous material storage** **Comments:**
P ☐ N/A ☒	**Masonry chimneys** **Comments:**
P ☐ N/A ☒	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**

Note: P= Present, N/A = Not Applicable

APPENDIX D

Quick Check Calculations

Degenkolb

Subject:	ASCE 41 Shear Stress check, Section 4.4.3.3	**Job Number:**	B8114004.00	**Date:**	12/26/18
Job:	UCB Seismic Eval, Cogeneration Plant	**By:**	ACL	**Section:**	
Model:	ASCE 41, TIER 1	**Checked By:**		**Page**	**of**

Lwall =	1620	in	
twall =	12	in	
Ms =	4.5	for RC wall, Collapse Prevention	
Aw =	19440		
f'c =	3000	psi	(assumed)
2*sqrt(f'c) =	110	psi	
vj-avg =	84	psi	

Degenkolb

Subject:	ASCE 41 Reinforcing Steel check	**Job Number:**	B8114004.00	**Date:**	12/26/18
Job:	UCB Seismic Eval, Cogeneration Plant	**By:**	ACL	**Section:**	
Model:	ASCE 41, TIER 1	**Checked By:**		**Page**	**of**

#4 at 12" o.c., each way, both faces

Vertical:			
twall =	12	in	
Abar =	0.2	in2	
spacing =	12	in	
rho =	0.0028	OK	> 0.002 horizontal minimum ratio
			> 0.0012 vertical minimum ratio

Degenkolb Engineers
1300 Clay St, 9th Floor
Oakland, CA 94612-2047
Phone: 510.272.9040
Fax: 510.272.9526

Subject:	Weight Take Off	**Job Number:**	B8114004.00	**Date:**	12/27/2018
Job:	1989 Cogeneration Plant	**By:**	ACL	**Section:**	
		Checked By:		**Page/of:**	

Mezzanine

	Area (ft2)	Thickness (in)	Weight (pcf)		Flat Load (psf)	
Slab	1511.8	5	150		62.5	3 1/2" conc. on 3" decking
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)	
W12x26	30			108	3.3	joists
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)	
W14x30	30			192	1.9	beams
					Convert to Flat Load (psf)	
mechanical					10.0	
	Area (ft2)					
Openings	77					

	Number of columns	Height (ft)	Weight (plf)	Weight (lbs)	Convert to Flat Load (psf)
Interior Column (5)W10x60	5	11	60	3300	2.2

	Thickness (in)	Length (ft)	Height (ft)	Weight (pcf)	Weight (lbs)	Convert to Flat Load (psf)
Exterior concrete walls	0	0	34	150	0	0
	Openings	2461	Area (ft2)			

Total Flat Load: (Slab + Joists)*(Area - Open)+Girder+Wall+ Col	113	kips
Effective Flat Dead Load (includes 10psf Partition)	88	psf

Roof

	Area (ft2)	Thickness (in)	Weight (pcf)		Flat Load (psf)	
Slab	9600.0	5	150		62.5	3 1/2" conc. on 3" decking
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)	
W12x26	30			96	3.8	joists
	PLF			Spacing (in, typ)	Convert to Flat Load (psf)	
W24x84	84			216	4.7	beams
					Convert to Flat Load (psf)	
mechanical					10.0	
	Area (ft2)					
Openings	333					

	Number of columns	Height (ft)	Weight (plf)	Weight (lbs)	Convert to Flat Load (psf)
Interior Column (5)W10x60	5	23.5	60	7050	4.7

	Thickness (in)	Length (ft)	Height (ft)	Weight (pcf)	Weight (lbs)	Convert to Flat Load (psf)
Exterior concrete walls	12	401.5	34	150	1678575	1110
	Openings	2461	Area (ft2)			

Total Flat Load: (Slab + Joists)*(Area - Open)+Girder+Wall+ Col	1556	kips
Effective Flat Dead Load (includes 10psf Partition)	1201	psf

Total building weight 1669 kips