Rating form completed by:

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Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

UC Santa Cruz building seismic ratings

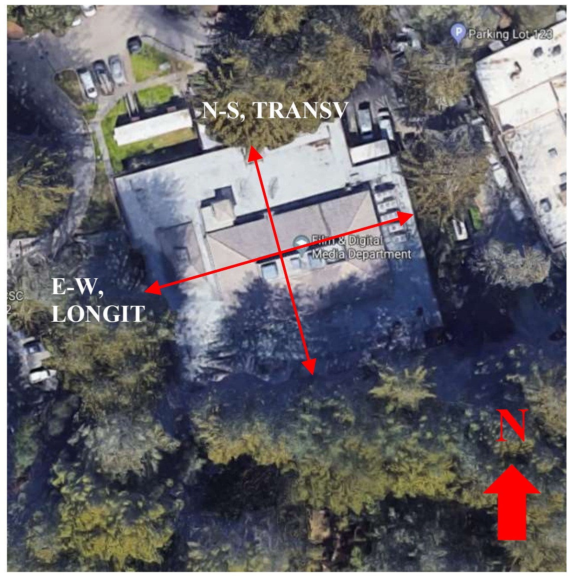
Communication Building

CAAN #7175

620 Baskin Circle, Santa Cruz, 95064

DATE: 2019-06-30

UCSC Campus: Main Campus



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	IV (Fair)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating	2019	
Recommended UC Santa Cruz priority category for retrofit	Priority B	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating[2]	None	
Is 2018-2019 rating required by UCOP?	Yes	
Further evaluation recommended?	Tier 2	Focused on column below discontinuous walls

[1] We translate this Tier 1 evaluation to a Seismic Performance Level rating using professional judgment. Non-compliant items in the Tier 1 evaluation do not automatically put a building into a particular rating category, but we evaluate such items along with the combination of building features and potential deficiencies, focused on the potential for collapse or serious damage to the gravity supporting structure that may threaten occupant safety. See Section III B of the UC Seismic Policy and Method B of Section 321 of the 2016 California Existing Building Code.

[2] Per Section 3.A.4.i of the Seismic Program Guidebook, the cost includes all construction cost necessitated by the seismic retrofit, including restoration of finishes and any triggered work on utilities or accessibility. It does not include soft costs such as design fees or campus costs. The cost is in 2019 dollars.

Building information used in this evaluation

- Structural drawings by Pregnoff & Matheu Structural Engineers, “Fine Arts & Communications, University of California – Santa Cruz” as-built dated 11-28-1966.
- Architectural drawings by Spencer, Lee & Busse Architects, “Fine Arts & Communications, University of California – Santa Cruz” as-built dated 11-28-1966.

Additional building information known to exist

- Architectural drawings by Spencer, Lee & Busse Architects, “Separate Contract for Excavation Work”, “Revisions to Windows Addendum No 2”, dated Feb 1967. “Cabinets and Door Changes”, dated Dec 1967. “New Wall at Loading Dock, Retaining Wall at South Elevation”, dated Jan 1968. “Lobby and Entry Revisions”, Mar 1968.

Scope for completing this form

Reviewed structural drawings for original construction and carried out a site visit to verify that the existing drawings matched the existing structure to the best of our knowledge. An ASCE 41-17 Tier 1 evaluation was completed. We did not perform an ASCE 41 Tier 1 nonstructural evaluation, but we looked for potentially hazardous nonstructural components during our site visit.

Brief description of structure

The Communications Building is a two-story concrete structure designed in 1966 by the architectural office of Spencer, Lee & Busse Architects and the structural office of Pregnoff & Matheu Structural Engineers.

The building is generally square in plan, with re-entrant corners at the northeast, southeast, and southwest corners. The structure is set on a sloping site resulting in the building presenting as one story above grade at the north and west façade, and two stories at the south and east façade. The building has approximately 39,000 sq. ft. of occupiable space with a footprint of roughly 132’ x 152’. The concrete low roof and high roof is set above the Lower Level floor by roughly 27.5’ and 35’ respectively. A wood framed roof portion is located over the lobby entry and over the high roof. These roofs serve as architectural features and should be treated as an appendage to the building. They are not considered to be part of the primary gravity or lateral support system.

<u>Identification of levels:</u> Two levels plus mezzanine. Lower Level floor at grade along the east and south perimeter walls, and below grade along the west and north perimeter walls; top of slab on grade at Lower Level at elevation 815.0’ along the perimeter and depresses 12” at the interior core. Main Floor, Mezzanine, Roof (consisting of low roof and high roof).

<u>Foundation system:</u> The foundation consists of strip footings supporting the concrete bearing/shear wall lines with an infill slab on grade. The site slopes down from west to east, and from north to south, retaining soil at the west and north perimeter walls for one story.

<u>Structural system for vertical (gravity) load:</u> The main floor and roof consist of 3-1/2” reinforced concrete slab supported by 11-1/2”x27-1/2” concrete joists at 48” spacing. At areas without floor joists, the slab thickness varies between 5” and 6”. The main concrete beams spanning from east to west are 24”x30”. Beams and joists all bear on reinforced concrete walls that vary in thickness from 8” at the interior, 12” at the interior core surrounding the studio, and 10” at the perimeter.

The roof is split into two levels, with the high roof over the building core at 35 feet above Lower Level and the surrounding low roof at 27.5 feet above Lower Level. There are two areas with wood roof framing instead of concrete slab. At the entry lobby, the roof framing consists of ½” plywood over 2x12 joists @ 24” o.c., which are supported by a grid of W10 steel beams. At the high roof, the framing consists of ½” plywood over 2x8 wood rafters and 2x4 studs at 16” o.c. The joists and studs bear on the high roof slab. The roof over the loading dock at the northeast corner consists of Robertson metal deck supported by steel beams.

A portion of the low roof has been removed to accommodate an elevator room and overrun structure which are not part of the original construction.

<u>Structural system for lateral forces:</u> Concrete diaphragms at the roof and main floor transfer lateral inertial forces to the foundation through reinforced concrete shear walls which vary from 8” to 12” thick. The shear wall layout is

evenly distributed on each side of the diaphragm in plan. The exterior walls and perimeter walls of the interior studio are continuous down to the foundation with exceptions noted under seismic deficiencies. Diaphragms are well anchored into supporting beams or walls with hooked rebar ends. The vertical wall bars are detailed to lap with footing dowels.

The wood framed roofs are sheathed with ½" plywood and fasten to the concrete walls with 5/8" diameter bolts at 24" o.c. These roofs do not serve as the primary lateral load resisting system.

Brief description of seismic deficiencies and expected seismic performance including mechanism of nonlinear response and structural behavior modes

Identified seismic deficiencies of the building include the following:

- Concrete shear walls on gridlines 4 and 5 that support the high roof slab are discontinuous below the main level and do not extend down to the foundation level. This represents a vertical discontinuity. The ends of the shear wall have continuity down to foundation through a column at one end, and perpendicular wall at the other. This system may result in overstress in the diaphragm adjacent to the wall, and excessive damage in the vertical elements supporting each end of the shear wall.

  Based on our review of the load path and the reinforcing in the wall and slab elements, we would anticipate moderate damage in this area but do not anticipate the vertical discontinuity to be a major building collapse hazard. If renovations for the building are planned, this should be evaluated further and could be improved with limited retrofit work on the supporting column.

Structural deficiency	Affects rating?	Structural deficiency	Affects rating?
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	N	Openings at shear walls (concrete or masonry)	N
Load path	N	Liquefaction	N
Adjacent buildings	N	Slope failure	N
Weak story	N	Surface fault rupture	N
Soft story	N	Masonry or concrete wall anchorage at flexible diaphragm	N
Geometry (vertical irregularities)	Y	URM wall height-to-thickness ratio	N
Torsion	N	URM parapets or cornices	N
Mass – vertical irregularity	N	URM chimney	N
Cripple walls	N	Heavy partitions braced by ceilings	N
Wood sills (bolting)	N	Appendages	N
Diaphragm continuity	N		

Summary of review of non-structural life-safety concerns, including at exit routes.[3]

Identified non-structural life-safety concerns of the building include the following:

- There are embedded river rocks, minimum 3" diameter, at the exterior face of perimeter concrete walls as an architectural feature. Although this feature occurs at the wall on the entry side of the building, we do not expect this to be a significant life safety falling hazard which would warrant a V(Poor) seismic performance rating.

[3] For these Tier 1 evaluations, we do not visit all spaces of the building; we rely on campus staff to report to us their understanding of the type and location of potential non-structural hazards.

UCOP non-structural checklist item	Life safety hazard?	UCOP non-structural checklist item	Life safety hazard?
Heavy ceilings, feature or ornamentation above large lecture halls, auditoriums, lobbies or other areas where large numbers of people congregate	None observed	Unrestrained hazardous materials storage	None observed
Heavy masonry or stone veneer above exit ways and public access areas	Possibly	Masonry chimneys	None observed
Unbraced masonry parapets, cornices or other ornamentation above exit ways and public access areas	None observed	Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.	None observed

Discussion of rating

The rating of IV takes into account that the building has a well-defined seismic-force path and defined lateral elements. There is an adequate length of concrete shear walls that are well distributed throughout the diaphragm. The walls are evenly laid out at both levels, thus there is no anticipated soft/weak story mechanism. The beams and joists have adequate shear reinforcing to withstand plastic deformation demands. The mezzanine level is well supported on all four sides to transfer lateral forces down to foundation. The building is not rated a III because of the discontinuous walls at gridlines 4 and 5.

Recommendations for further evaluation or retrofit

Although we rate the building as IV (Fair), we recommend that the Campus perform a more detailed review of the discontinuous walls at the main level, namely assessing the capacity of the column below to maintain gravity-load resisting capacity in an earthquake, and the performance of the slab to transfer lateral force to the shear walls below. Verifying the connection and strength of the river rock façade to the concrete walls would also lend more confidence in its ability to withstand seismic forces. We put the building on Priority Category B, as the above items should be done if there are any plans for modifying the building.

Peer review of rating

This seismic evaluation was discussed in a peer review meeting on 17 June 2019. The reviewer present was Bret Lizundia of R+C. Comments from the reviewer have been incorporated into this report. The reviewer agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	37.000833	
Longitude	-122.061537	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	3	Including Mezzanine
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	39,888	
Risk Category per 2016 CBC Table 1604.5	II	Offices & classrooms
Building structural height, h_n	38.2 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Estimated using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Estimated using ASCE 41-17 equation 4-4 and 7-18
Estimated fundamental period	0.31 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18

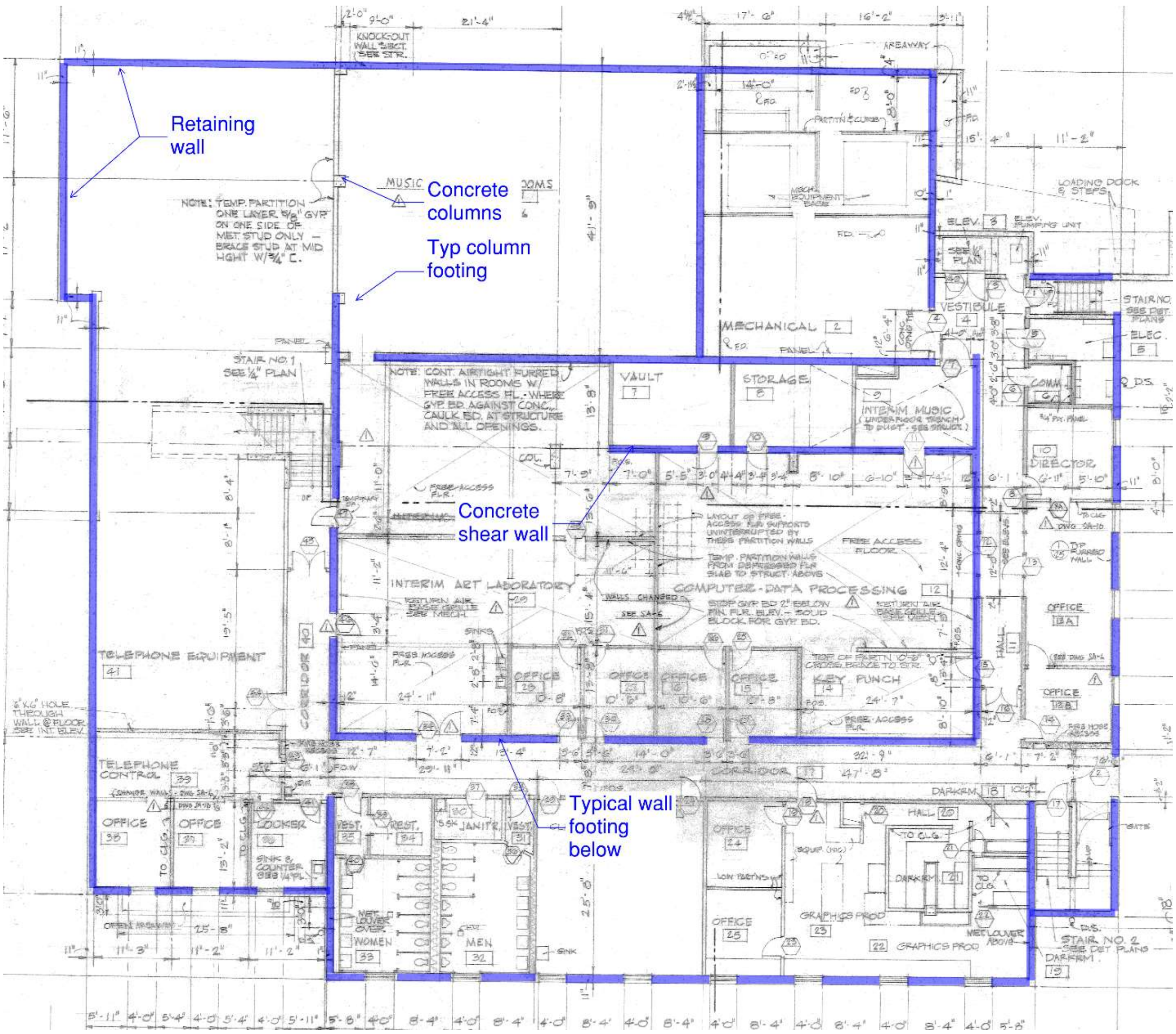
Site data		
975 yr hazard parameters S_s, S_1	1.286, 0.488	
Site class	D	
Site class basis[4]	Geotech	See footnote below
Site parameters F_a, F_v[5]	1, 1.81	
Ground motion parameters S_{cs}, S_{c1}	1.286, 0.885	
S_a at building period	1.54	
Site V_{s30}	900 ft/s	
V_{s30} basis	Estimated	Estimated based on site classification of D.
Liquefaction potential	Low	
Liquefaction assessment basis	County map	See footnote below
Landslide potential	Low	
Landslide assessment basis	County map	See footnote below
Active fault-rupture identified at site?	No	
Fault rupture assessment basis	County map	See footnote below
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 1966 Code: 1964 UBC	Assumed
Applicable code for partial retrofit	None	No partial retrofit
Applicable code for full retrofit	None	No full retrofit
Model building data		
Model building type North-South	C2 – Concrete (Rigid Diaphragm)	
Model building type East-West	C2 – Concrete (Rigid Diaphragm)	
FEMA P-154 score	N/A	Not included here. Tier 1 evaluation.
Previous ratings		
Most recent rating	none	
Date of most recent rating	-	
2nd most recent rating	-	
Date of 2nd most recent rating	-	

[4] Determination of site class and assessment of geotechnical hazards are based on correspondence with Pacific Crest Geotechnical Engineers and Nolan, Zinn, and Associates Geologists. [*Revised Geology and Geologic Hazards, Santa Cruz Campus, University of California*, Job # 04003-SC 13 May 2005]. Site class is taken as D throughout the main campus of UC Santa Cruz. The following links provide hazard maps for liquefaction, landslide, and fault rupture:
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LiquifactionMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LandslideMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/FaultZoneMap2009.pdf

[5] F_V factor used does not include the requirements of Section 11.4.8-3 of ASCE 7-16 that are applicable to Site Class D, and which per Exception 2 would result in an effective F_V factor of 2.72 (1.5 times larger). At the Santa Cruz main campus this only affects structures with T>0.69 seconds. We understand that the appropriateness of this requirement of Section 11.4.8 might be reviewed by UCOP.

3rd most recent rating	-	
Date of 3rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file

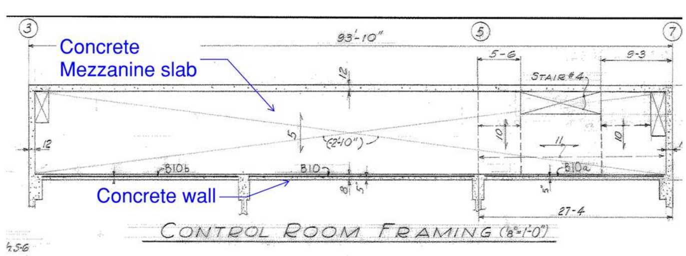
Annotated Foundation plan



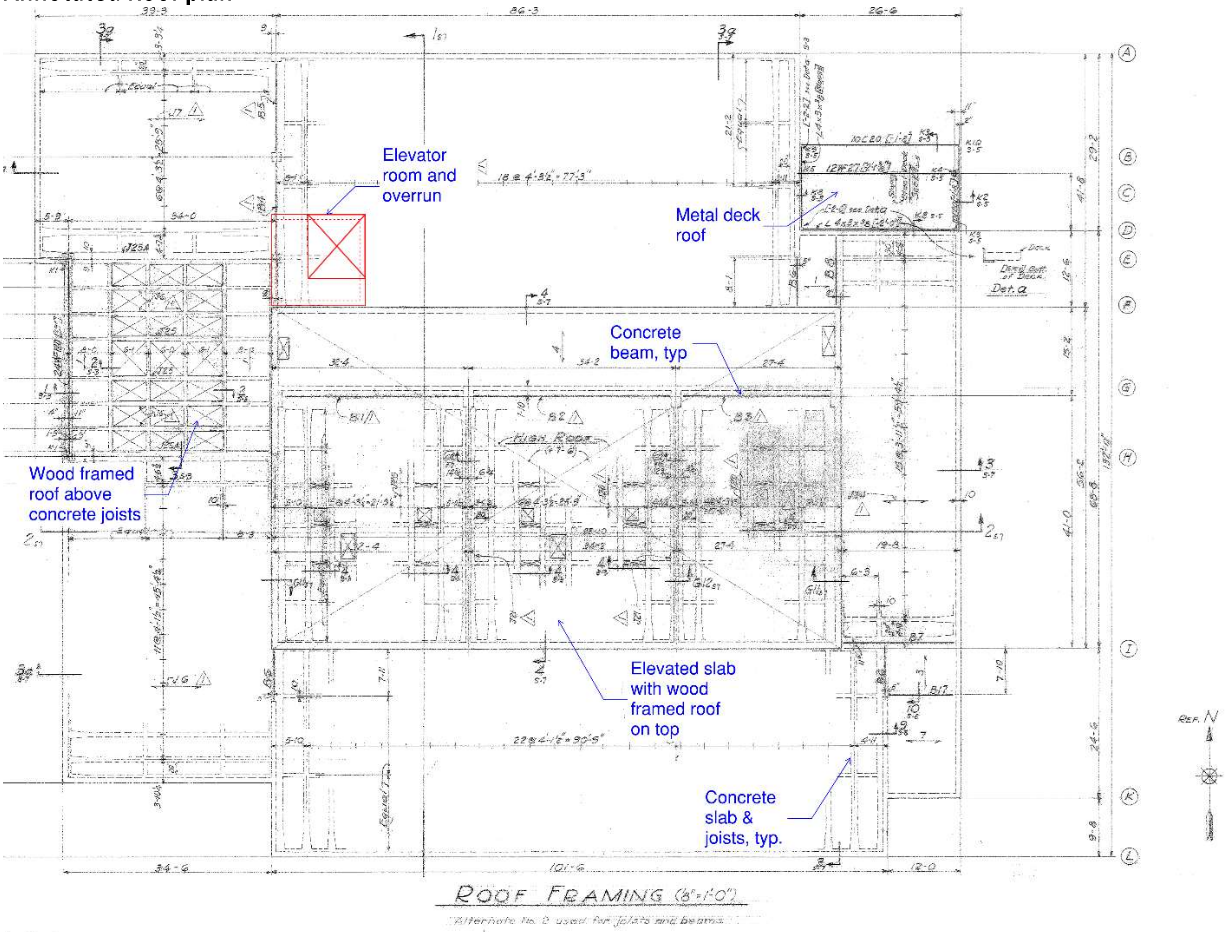
Annotated Main Floor plan:

[redacted]

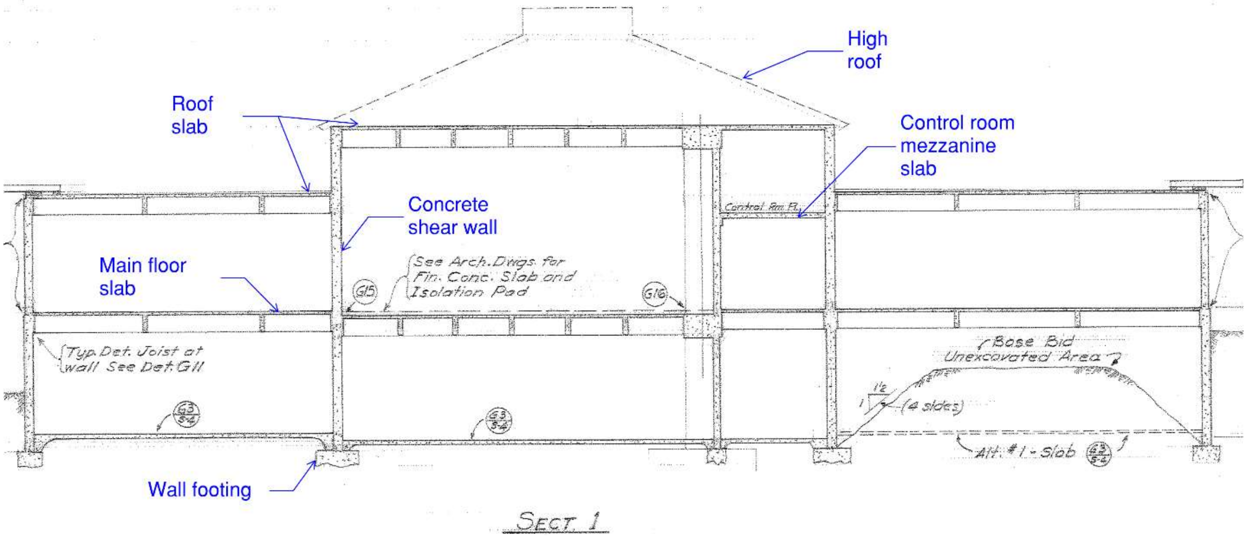
Annotated Mezzanine plan:



Annotated Roof plan



Annotated building section:



Loading dock on northeast side of building

Entry at west side of building

Exposed aggregate at entry at west side of building

East side of building

Table 17-2. Collapse Prevention Basic Configuration Checklist

Status	Evaluation Statement
Low Seismicity	
Building System—General	
C NC N/A U	LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation.
C NC N/A U	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity.
C NC N/A U	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure.
Building System—Building Configuration	
C NC N/A U	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above.
C NC N/A U	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above.
C NC N/A U	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation.
C NC N/A U	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines.
C NC N/A U	MASS: There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered.
C NC N/A U	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension.

Diaphragm discontinuity at main level.

Status	Evaluation Statement
Moderate Seismicity (Complete the Following Items in Addition to the Items for Low Seismicity)	
Geologic Site Hazards	
C NC N/A U	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2 m) under the building.
C NC N/A U	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure.
C NC N/A U	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated.
High Seismicity (Complete the Following Items in Addition to the Items for Moderate Seismicity)	
Foundation Configuration	
C NC N/A U	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$.
C NC N/A U	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C.

93ft/38ft = 2.4 > 0.6*1.15g=0.69

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

Table 17-24. Collapse Prevention Structural Checklist for Building Types C2 and C2a

Status	Evaluation Statement	
Low and Moderate Seismicity		
Seismic-Force-Resisting System		
C NC N/A U	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system.	
C NC N/A U	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2.	
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 $2\sqrt{f'_c}$.	
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.	
Connections		
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.	
C NC N/A U	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls.	Hooked end per slab schedule detail.
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.	
High Seismicity (Complete the Following Items in Addition to the Items for Low and Moderate Seismicity)		
Seismic-Force-Resisting System		
C NC N/A U	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components.	
C NC N/A U	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints.	
C NC N/A U	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.	
Diaphragms (Stiff or Flexible)		
C NC N/A U	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints.	Roof: raised wood diaphragm supported on 4 sides with conc. wall. Floor: 5" depression in concrete slab with continuity through bond beam
C NC N/A U	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length.	High roof and low roof have full shear transfer connectivity along the length of wall.
Flexible Diaphragms		
C NC N/A U	CROSS TIES: There are continuous cross ties between diaphragm chords.	
C NC N/A U	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered.	
C NC N/A U	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing.	
C NC N/A U	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.	This section does not apply since wood framed roof area does not serve as the primary lateral force resisting system of the building.
C NC N/A U	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing.	
Connections		
C NC N/A U	UPLIFT AT PILE CAPS: Pile caps have top reinforcement, and piles are anchored to the pile caps.	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

ASCE 41-17 - Tier 1 Calculations
Communication Building

Building Properties:

Seismic Parameters:

Risk Category: II 2016 CBC table 1604.5

Site Class: D Assumed

Probability: 5% in 50 years

$S_{XS} = 1.542$ for BSE-2E hazard level

$S_{X1} = 0.884$ for BSE-2E hazard level

Seismic Forces:

$T = C_t \cdot h_n^{\beta} \rightarrow 0.31$ sec (ASCE 41-17 Eqn. 4-4)

$C_t = 0.02$ for all other framing systems

$\beta = 0.75$ for all other framing systems.

$h_n = 38.2$ ft

$S_a = min\left(\frac{S_{X1}}{T}, S_{XS}\right) \rightarrow 1.54$ g (ASCE 41-17 Eqn. 4-3)

$V_{base} = C_{base} \cdot S_a \cdot W_{total} \rightarrow 20{,}989\, kips$ (ASCE 41-17 Eqn. 4-1)

$C_{base} = 1.4$ (ASCE41-17 Table 4-7) worst case (1 level of C2)

$V_{L02} = C_{roof} \cdot S_a \cdot roof_{weight} \rightarrow 8{,}840\, kips$ (ASCE 41-17 Eqn. 4-1)

$C_{roof} = 1.3$ (ASCE41-17 Table 4-7) worst case (1 level of W2)

Building Weight:

$A_{floor} = 18400 ft^2 + 1276 ft^2 \rightarrow 19{,}676 ft^2$

$floor_{unit,weight} = \Sigma\left(tbl_{floor\,Unit_{weight}}\right) \rightarrow 270\, psf$

$floor_{weight} = \Sigma\left(tbl_{floor\,Weight_{floor}}\right) \rightarrow 5{,}313\, kips$

$roof_{unit,weight} = \Sigma\left(tbl_{roof\,Unit_{weight}}\right) \rightarrow 245\, psf$

$roof_{weight} = \Sigma\left(tbl_{roof\,Weight_{roof}}\right) \rightarrow 4{,}410\, kips$

$A_{roof} = 18000 ft^2$

$W_{total} = floor_{weight} + roof_{weight} \rightarrow 9{,}723\, kips$

Load Distribution:

tblFloorShear

Floor	W	h	M'	C_{story}	V_{story}	V_{total}
Roof	4,410 kips	38.2 ft	168,462,000 lbs·ft	0.69	14,403 kips	14,403 kips
Main	5,313 kips	14.5 ft	77,031,540 lbs·ft	0.31	6,586 kips	20,989 kips

$M' = W \cdot h$

$C_{story} = \frac{M'}{\Sigma\left(tblFloorShear_{M'}\right)}$

$V_{story} = C_{story} \cdot V_{base}$

ASCE 41-17 - Tier 1 Calculations

Communication Building

Sum of Effective wall lengths accounting for openings:

$L_{Roof,NS} = 130\,ft + 41\,ft + 41\,ft + 41\,ft + 41\,ft + 12\,ft + 18\,ft + 6\,ft \rightarrow 330\,ft$ ← governs

$L_{Roof,EW} = 182\,ft + 96\,ft + 71\,ft + 101\,ft \rightarrow 450\,ft$

$L_{Main,NS} = 192\,ft + 85\,ft + 41\,ft + 41\,ft \rightarrow 359\,ft$ ← governs

$L_{Main,EW} = 234\,ft + 96\,ft + 71\,ft + 101\,ft \rightarrow 502\,ft$

Roof Level - C2 Shear Stress Check: ASCE 41-17 Sec. 4.4.3.3

$V_{roof} = query(\,tblFloorShear\,,\,Floor = Roof\,,\,V_{total}\,) \rightarrow 14{,}403\,kips$

$A_{w,Roof,C2} = L_{Roof,NS} \cdot 10\,in \rightarrow 39{,}600\,in^2$ Sum of Walls in governing direction

$M_{s,C2} = 4.5$ (ASCE 41-17 Table 4-8, Reinf. Conc wall, CP)

$$v_{j,Roof} = \frac{1}{M_{s,C2}} \cdot \left(\frac{V_{base}}{A_{w,Roof,C2}}\right) \rightarrow 118\,psi$$

$$v_n = 2 \cdot \sqrt{3750\,psi \cdot psi} \rightarrow 122\,psi$$

Shear stress OK with concrete only

Floor Level - C2 Shear Stress Check: ASCE 41-17 Sec. 4.4.3.3

$V_{main} = query(\,tblFloorShear\,,\,Floor = Main\,,\,V_{total}\,) \rightarrow 20{,}989\,kips$

$A_{w,C2} = L_{Main,NS} \cdot 10\,in \rightarrow 43{,}080\,in^2$ assuming 2 bays of wall in each direction, conservative

$$v_j = \frac{1}{M_{s,C2}} \cdot \left(\frac{V_{base}}{A_{w,C2}}\right) \rightarrow 108\,psi$$

$$v_n = 2 \cdot \sqrt{3750\,psi \cdot psi} \rightarrow 122\,psi$$

Shear stress OK with concrete only

Reinforcing Steel Check

ρ not less than 0.0012 vertical, 0.002 horizontal

Concrete Wall 6"-8": #4 @ 10" o.c., EW in center

$$\rho = \frac{A_s}{t_{wall} spcg}$$

$$\rho_1 = \frac{.19\,in^2}{8\,in \cdot 10\,in} \rightarrow 0.0024$$

Concrete Wall 9"-12": #4 @ 12" o.c., E.W., E.F.

$$\rho_1 = \frac{2 \cdot .19\,in^2}{12\,in \cdot 12\,in} \rightarrow 0.0026$$

Concrete Wall 13"-18": #5 @ 12" o.c.,E.W., E.F.

$$\rho_1 = \frac{2 \cdot .307\,in^2}{18\,in \cdot 12\,in} \rightarrow 0.0028$$

Concrete Wall 19"-24": #6 @ 12" o.c., E.W., E.F.

$$\rho_1 = \frac{2 \cdot .44\,in^2}{24\,in \cdot 12\,in} \rightarrow 0.0031$$

Deflection Compatibility Check

Typical 44" Wide Columns:

#8 Longit. Bars

$$M_{n,e,col2} = 1.25 \cdot 60\,ksi \cdot \left(2 \cdot .786 in^2 \cdot 41\,in + 2 \cdot .786 in^2 \cdot 32\,in\right) \rightarrow 8{,}607\,kip \cdot in$$

$$d_1 = 44\,in - 2\,in - .5\,in \rightarrow 41.5\,in$$

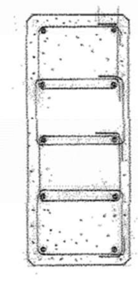
$$V_{max,col2} = \frac{2 \cdot M_{n,e,col2}}{13\,ft} \rightarrow 110\,kips$$

$$V_{c2} = 2 \cdot \sqrt{3750\,psi \cdot psi} \cdot 18\,in \cdot d_1 \rightarrow 91.5\,kips$$

$$V_{s2} = 60\,ksi \cdot 2 \cdot \frac{0.11 in^2 \cdot d_1}{12\,in} \rightarrow 45.7\,kips$$

$$V_{n2} = V_{c2} + V_{s2} \rightarrow 137\,kips$$

Ductility of RECT Column OK



Sect X-2

Typical 18" Wide Columns:

#10 Longit. Bars

$$M_{n,e,col1} = 1.25 \cdot 60\,ksi \cdot 2 \cdot 1.27 in^2 \cdot d_1 \rightarrow 7{,}906\,kip \cdot in$$

$$d_2 = 18\,in - 2\,in - .625\,in \rightarrow 15.4\,in$$

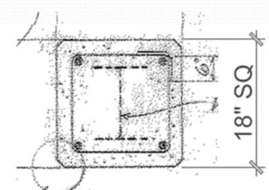
$$V_{max,col1} = \frac{2 \cdot M_{n,e,col1}}{13\,ft} \rightarrow 101\,kips$$

$$V_{c1} = 2 \cdot \sqrt{3750\,psi \cdot psi} \cdot 18\,in \cdot d_2 \rightarrow 33.9\,kips$$

$$V_{s1} = 60\,ksi \cdot 2 \cdot \frac{0.11 in^2 \cdot d_2}{12\,in} \rightarrow 16.9\,kips$$

$$V_{n1} = V_{c1} + V_{s1} \rightarrow 50.8\,kips$$

Ductility of SQ Column OK



Sect X-1

Joists J1:

3-#10 Top Governs

$$M_{n,e,jst} = 1.25 \cdot 60\,ksi \cdot 3 \cdot 1.27 in^2 \cdot 25\,in \rightarrow 7{,}144\,kip \cdot in$$

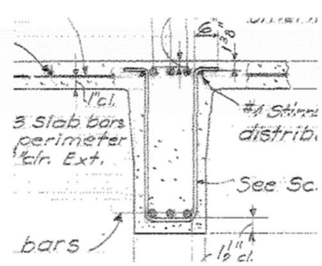
$$V_{max,jst} = \frac{2 \cdot M_{n,e,beam}}{34.25\,ft} \rightarrow 214\,kips$$

$$V_{c,jst} = 2 \cdot \sqrt{4000\,psi \cdot psi} \cdot 11.5\,in \cdot 25\,in \rightarrow 36.4\,kips$$

$$V_{s,jst} = 60\,ksi \cdot 2 \cdot 0.11 in^2 \cdot \frac{25\,in}{6\,in} \rightarrow 55\,kips$$ For #3 Stirrups @ 6" o.c. at support

$$V_{n,jst} = V_{c,jst} + V_{s,jst} \rightarrow 91.4\,kips$$

Ductility of Joist OK



Deflection Compatibility Check

Beam B2:

14-#11 Top Governs

$$M_{n,e,beam} = 1.25 \cdot 60\,ksi \cdot 14 \cdot 1.56in^2 \cdot 26.8\,in \rightarrow 43{,}898\,kip \cdot in$$

$$V_{max,beam} = \frac{2 \cdot M_{n,e,beam}}{26.8\,ft} \rightarrow 273\,kips$$

$$V_c = 2 \cdot \sqrt{4000\,psi \cdot psi} \cdot 48\,in \cdot 26.8\,in \rightarrow 163\,kips$$

$$V_s = 60\,ksi \cdot 4 \cdot 0.19in^2 \cdot \frac{26.8\,in}{4\,in} \rightarrow 306\,kips$$ For 4-legs #4@4" o.c.

$$V_n = V_c + V_s \rightarrow 468\,kips$$

Ductility of Beam OK