Rating form completed by:

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Evaluator: JY/WAL/BL

Date: 07/29/2019

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

REGISTERED PROFESSIONAL ENGINEER
BRET LIZUNDIA
No. S3950
Exp. 12-31-20
STRUCTURAL
STATE OF CALIFORNIA

07-29-19

DATE: 2019-07-29

UC Santa Cruz building seismic ratings

MT Hamilton Dorm #1

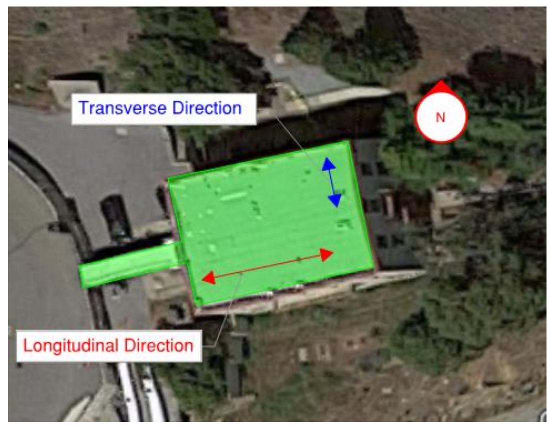
CAAN #7213

29965 MT HAMILTON RD

UCSC Campus: Mt Hamilton Campus

East Elevation (Looking Southeast)

Plan



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
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]	High ($200-$400/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	Building was not previously rated.
Further evaluation recommended?	Yes	See recommendations on further evaluation and retrofit.

[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 19 May 2017 *UC Seismic Safety Policy* and Method B of Section 321 of the 2016 *California Building Code*.

[2] Per Section III.A.4.i of the 26 March 2019 *UC Seismic Program Guidebook, Version 1.3*, 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

- Partial drawings by John Galen Howard Architect, "Dormitory at Lick Observatory Mt. Hamilton," dated 19 August 1912. These were located in the facility manager's office on site at the Observatory.

Additional building information known to exist

The 3 April 1998 seismic evaluation by Wildman & Morris indicated that concrete testing was done in 1976, and it indicated an average concrete capacity of f'_c = 2,000 psi.

Scope for completing this form

Reviewed part of the existing blueprint for the original construction, made brief site on 11 June 2019, and carried out ASCE 41-17 Tier 1 evaluation.

Brief description of structure

The Mt. Hamilton Dormitory #1 building has three full stories plus a partial basement. It is a reinforced concrete building located to the east of the parking and drive aisle on the east side of the Lab and Measurement Building. Grade at the site steps down to the east. A 40'0" long east-west exit structure is attached to the west end of the building and has access to the first, second and third floors of the building. The west end of the top (roof) level of the exit structure connects the third floor of the building to the upper vehicular and parking area adjacent to the Lab and Measurement Building. There is a small parking area on the south side of the exit structure at the second level of the building. The parking area is reached by a ramp down from the main parking area adjacent to the Lab and Measurement Building. The first floor and basement are below grade on the west side but above or partially above grade at all the other sides. The basement is divided into two areas by a 12" concrete shear wall: the west side is the storage room measuring 27'-10" in the E-W direction and 40'-0" N-S direction; the east side is crawl space. The building out-to-out dimension is 65'-0" in the E-W longitudinal direction and 40'-0" in the N-S transverse direction. The story height at the first, second, and third stories is 10'-7". The story heights at the basement storage room and the crawl space are 8'-11" and 5'-6", respectively. Around the roof perimeter, there is a parapet wall that is approximately 3'-0" high. The building was designed in 1912 by architect John Galen Howard. An independent structural engineer is not listed on the structural drawings.

The 1912 drawings found at the Observatory site only shows the eastern end of the exit structure on the west side of the building, and the details on the architectural drawings differ in some ways from what was observed in the field. There are no structural drawings for the exit structure. It appears to be concrete. It may be that the exit structure was built at a later date. There is no separation between the exit structure and either the dormitory to the east or the retaining wall to the west. The west end of the exit structure has an arched opening at the second floor supporting the roof above. The west end connection to the retaining wall has deterioration, spalling, and corroded rebar. Wood shoring appears to have been installed to support the arched opening.

Building condition: Exterior walls are covered in stucco. Paint is peeling, and there is some limited, mostly hairline cracking. However, two concrete balconies at the second floor are severely deteriorated with rusted railings, spalled concrete landings, and exposed, rusted rebar in the landings. The third floor is used as the dorm rooms for students; the second floor is abandoned; the first floor is occupied by the university staff; the basement is used as storage room. Stairs in the building are accessible to all levels. Fire exit stairs outside the east elevation of the building show signs of substantial corrosion. The plaster decorations on the exterior wall and the brick ornament around the windows appears stable, but how they are anchored back to the building is unknown. Loose roof tiles were seen at the roof perimeter; the facility coordinator for the site indicated that the tiles contain wire tires to the roof, but the wires are corroding.

Identification of levels: The building has three stories from the lowest grade level and a basement that is partially below grade. On the west end, the second floor is at the same elevation as the terrace level which is used a parking lot; the third floor connects via a walkway on the roof of the exit structure to the upper parking and drive aisle east of the Lab and Measurement Building.

Foundation system: The concrete shear walls in the basement level bear on the 24" wide by 18" thick strip footings. Interior columns sit on the concrete spread footings that are 3'-0" long by 3'-0" wide by 2'-6" deep. Exterior columns that are partially embedded in the concrete shear walls and bear on locally enlarged footings that match the size of the interior column footings. No reinforcement is provided in the strip footings, and the spread footings are reinforced with three ½-inch square bars both ways at 6" above the bottom of the concrete.

Structural system for vertical (gravity) load: The concrete floor and roof slabs span to east-west concrete beams, which are supported by north-south concrete girders and interior concrete columns and perimeter concrete columns embedded in the concrete shear walls as pilasters. Beams and slabs are present at the perimeter and are integrated into the wall reinforcing as thickened elements on the interior face of the wall. The floor slabs are 3-1/2" thick; the roof slab is 3" thick. Drawing notes indicate cement floor finishes in corridors, stairs, balconies, laundry rooms, basement and restrooms, with wood floors in remaining area. Drawing notes indicate the floor slabs are reinforced with 3/8" square bars at 7" o.c., and the roof slab is reinforced with 5/!6" square bars at 7" o.c. A cross section implies that these notes likely refer to bottom bars with a set of top bars centered over the beams for negative moment. Temperature and shrinkage bars are provided parallel to the beams.

The concrete beams at the floors are typically 10" wide by 18" deep and reinforced with two ¾" square bars at the bottom and two ¼" square bars at the top. The concrete girders are typically 12" wide by 20" deep reinforced with three 7/8" square bars at the bottom and three ¼" square bars at the top. Both the beam and the girder are reinforced with 3/16" diameter stirrups that are closer at the ends and further apart to the interior, and no ties are provided in the center half of the span. In the girder, top bars bend down at quarter points and run as bottom bars in the center of the girder. Additional ¼-inch square 'continuity bars' are provided in the slab at the girder locations which extends into the exterior face of the shear wall and ends with a 15" hook.

The concrete columns are 14" by 14" in the basement and first story, 12" by 12" in the second story, and 10" by 10" in the third story. They are typically reinforced with four longitudinal bars with #3 round spiral ties at 3" o.c.; the longitudinal bars range in size from 7/8" square used in some of the basement interior columns to 3/8" square at the third story columns.

The concrete walls are 12" thick below the first level and 6" above; they are typically reinforced with 3/8-inch bars at 12" o.c. both ways at the center of the cross section.

Structural system for lateral forces: Lateral loads are transferred from the concrete slab diaphragm to the perimeter concrete shear walls. However, details for the reinforcing bars in the slab and their connections to the concrete walls are not clear. Where the concrete girders occur, the floor bars are bent into the exterior face of the wall with a 90-degree, 15" long hook; however, details in between the girders are not shown. Although it is likely that slab bars connect to the perimeter beams on the north and south sides, details are not shown, and on the west and east sides, the only connection in between beams may be the temperature bars in the slab. The lateral force in the wall is transferred into the perimeter strip footings and then into the ground; however, the wall reinforcement is not hooked into the footings, and the strip footings are unreinforced. The potential lack of sufficient positive connection between lateral force-resisting system elements may limit the capacity of the structure in a seismic event.

Response in the Loma Prieta Earthquake: There is a strong motion station at the Lick Observatory, identified on the California Geologic Survey strongmotioncenter.org website as UCB - BDSN Station MHC. Recordings do not go back to the 17 October 1989 Loma Prieta Earthquake. There are recordings for the 30 October 2007 Alum Rock Earthquake (with 0.068 and 0.048 horizonal peak ground accelerations and 0.082 vertical PGA) and the 30 March 2009 Morgan Hill Earthquake (with 0.074 and 0.052 horizontal PGAs and 0.034 vertical PGA). There is a station about 6 km west of Mt. Hamilton (CGS Station 57191 Halls Valley - Grant Park) that recorded the Loma Prieta Earthquake with 0.13 and 0.11 horizontal PGAs and 0.06 vertical PGA. Damage in any of these events is not known, but the levels of shaking on the mountain were likely relatively small.

Building code: The 1912 building pre-dates the first Uniform Building Code in 1927. It is thus a "pre-code" building.

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:

- Wall stresses exceed the Tier 1 shear stress limit in the narrower north-south transverse direction at the first and second stories, with a maximum of 136 psi vs the allowable capacity of 100 psi.
- The connections between the floor and roof diaphragms to the shear walls are not clear. If the diaphragm is not adequately connected for transfer of seismic forces to the shear wall, the ability of the walls to receive seismic forces is limited, and the overall seismic force resistance of the building is reduced.
- The wall strip footings are unreinforced, and the wall vertical reinforcement is not hooked into the footing. As a result, the current foundation system may not have sufficient capacity to resist the shear and moment from seismic forces.
- Badly deteriorated balconies are falling hazard for passerby and potentially unsafe for use. Even though the second floor, where the balconies are located, is abandoned, the stairs inside the building can access all levels including the second floor.
- There is no seismic separation at the exit structure to the retaining wall on the west side. When the dormitory and connected exit structure moves away from the retaining wall as the exit structure, the west end of the arched opening may lose vertical support from the retaining wall. Wood shoring has been installed as a backup vertical load-carrying support path.

Structural deficiency	**Affects rating?**	**Structural deficiency**	**Affects rating?**
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	Y	Openings at shear walls (concrete or masonry)	N
Load path	Y	Liquefaction	N
Adjacent buildings	Y	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)	N	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 nonstructural life-safety concerns, including at exit routes.[3]

The structural integrity of the exit structure and its connection to the structure and the retaining walls are not clear. Since it connects to the third floor which is still in use as students' dorm rooms, it may become an exit route during an extreme event. The deteriorated second floor balcony landings are a significant falling hazard. Loose tiles on the roof are a falling hazard especially when over the exit routes. In addition, the fire escape on the east side is heavily corroded.

UCOP nonstructural checklist item	**Life safety hazard?**	**UCOP nonstructural 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	None observed	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

[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 if and where nonstructural hazards may occur.

Basis of rating

The building is assigned a Seismic Performance Level rating of V, due to the deficiencies noted above including shear wall shear stresses that exceed the Tier 1 criterion, a potentially inadequate load path between the floor and roof diaphragms and the walls, limited capacity to transfer loads to the footings, unreinforced strip footings, significantly deteriorated balcony landings, and deterioration and a lack of adequate separation and independent gravity support at the west end of the west exit structure.

Recommendations for further evaluation or retrofit

- We recommend that the campus perform a Tier 2 evaluation to review the adequacy of the connection of the concrete diaphragm to the concrete shear wall and the exit structure, including selective field investigation to determine reinforcing details at the diaphragm-to-wall interface.
- We recommend the second floor balconies to be removed or repaired in the near future to limit continued spalling and propagation of corrosion into the main structure. The corrosion at the east fire escape should be reviewed to determine if the escape is safe to use.
- The wood shoring at the west end of exit structure should remain in place until an adequate seismic separation and independent vertical load-carrying support system is installed.

Peer review of rating

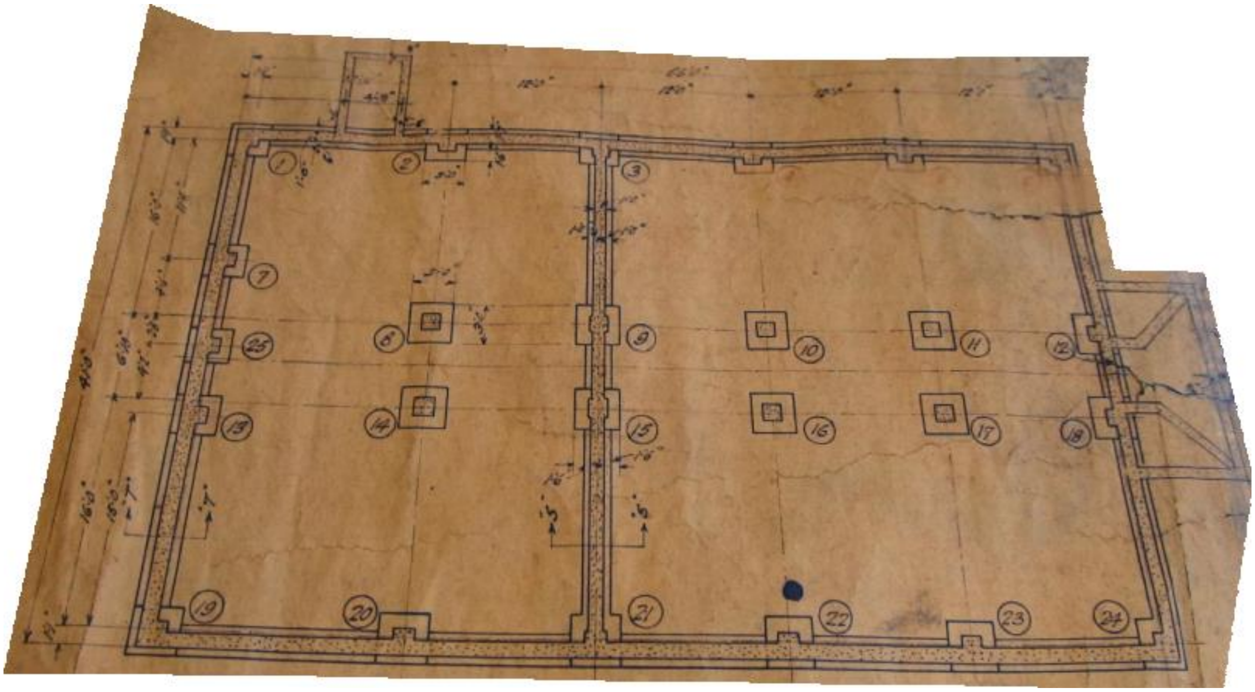
This seismic evaluation was discussed in a peer review meeting on 24 July 2019. Reviewers present were Noelle Yuen of Maffei Structural Engineering and Jay Yin of Degenkolb Engineers. Comments from the reviewers have been incorporated into this report. The reviewers agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	37.341725	
Longitude	-121.640540	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	3	The building is below grade on the west side 2 levels.
Number of stories (basements) below lowest perimeter grade	1	
Building occupiable area (OGSF)	9,164	From UCSC facilities database.
Is the building on a hillside site?	N	
Risk Category per 2016 CBC Table 1604.5	II	
Estimated fundamental period	0.33 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Building structural height, h_n	42 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
Site data		
975-year hazard parameters S_s, S_1	2.216, 0.78	From SEAOC/OSHPD website
Site class	B	
Site class basis	Inferred	The Lick Observatory complex is built on a rocky outcropping at the top of Mt. Hamilton. Fractured rock supporting the footings is visible in the crawl space.

Site parameters F_a, F_v	0.9, 0.8	From SEAOC/OSHPD website
Ground motion parameters S_{cs}, S_{c1}	1.682, 0.549	From SEAOC/OSHPD website
S_a at building period	1.66	
Site V_{s30}	3,750 ft/s	
V_{s30} basis	Estimated	Estimated based on site classification of B, using middle of 2,500-5,000 ft/s range.
Liquefaction potential	Low	
Liquefaction assessment basis	Inferred	Engineering judgment given the lack of surficial soils and mountaintop location.
Landslide potential	Low	
Landslide assessment basis	Inferred	Engineering judgment given the building site at the base of the building is relatively level and there is a retaining wall on the west side.
Active fault rupture identified at site	No	
Fault rupture assessment basis	CGS Website	The Earthquake Zones of Required Investigation Lick Observatory Quadrangle has no Earthquake Fault Zones near Mt. Hamilton. The Mt. Hamilton area was "not evaluated for liquefaction or landslides." See http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/LICK_OBSERVATORY_EZRIM.pdf
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 1912 Code: Pre-code	Design date precedes the initial 1927 UBC.
Applicable code for partial retrofit	None	No partial retrofit.
Applicable code for full retrofit	None	No full retrofit
FEMA P-154 data		
Model building type north-south	C2-Concrete shear wall with rigid diaphragm	C2 checklist in ASCE 41-17.
Model building type east-west	C2-Concrete shear wall with rigid diaphragm	C2 checklist in ASCE 41-17.
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
Previous ratings		
Most recent rating	IV (Fair)	
Date of most recent rating	1998	
2nd most recent rating	-	
Date of 2nd most recent rating	-	

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

Foundation Plan

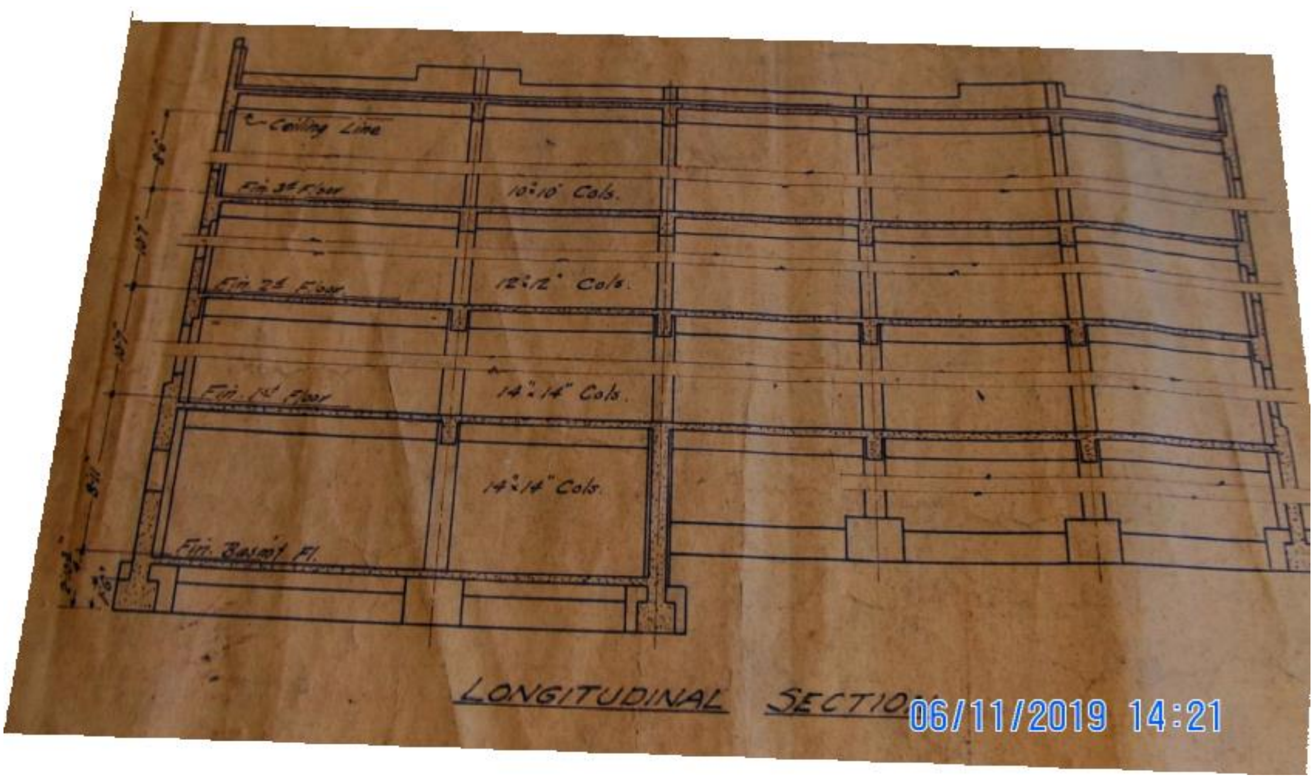


Typical Plan at the 1st, 2nd, and 3rd Floors

[redacted]

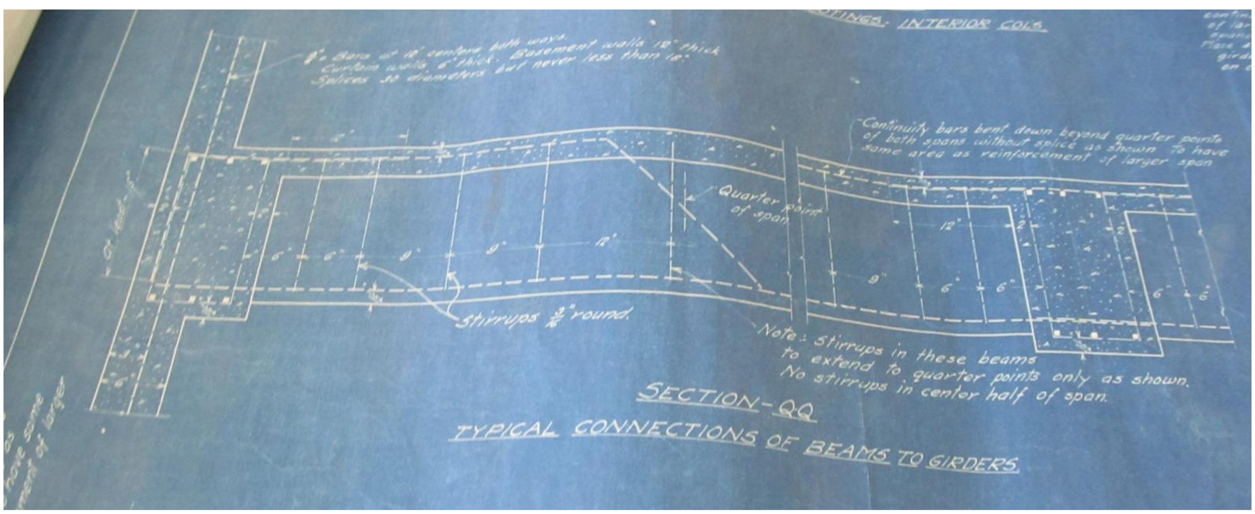
Roof Plan

Longitudinal Section

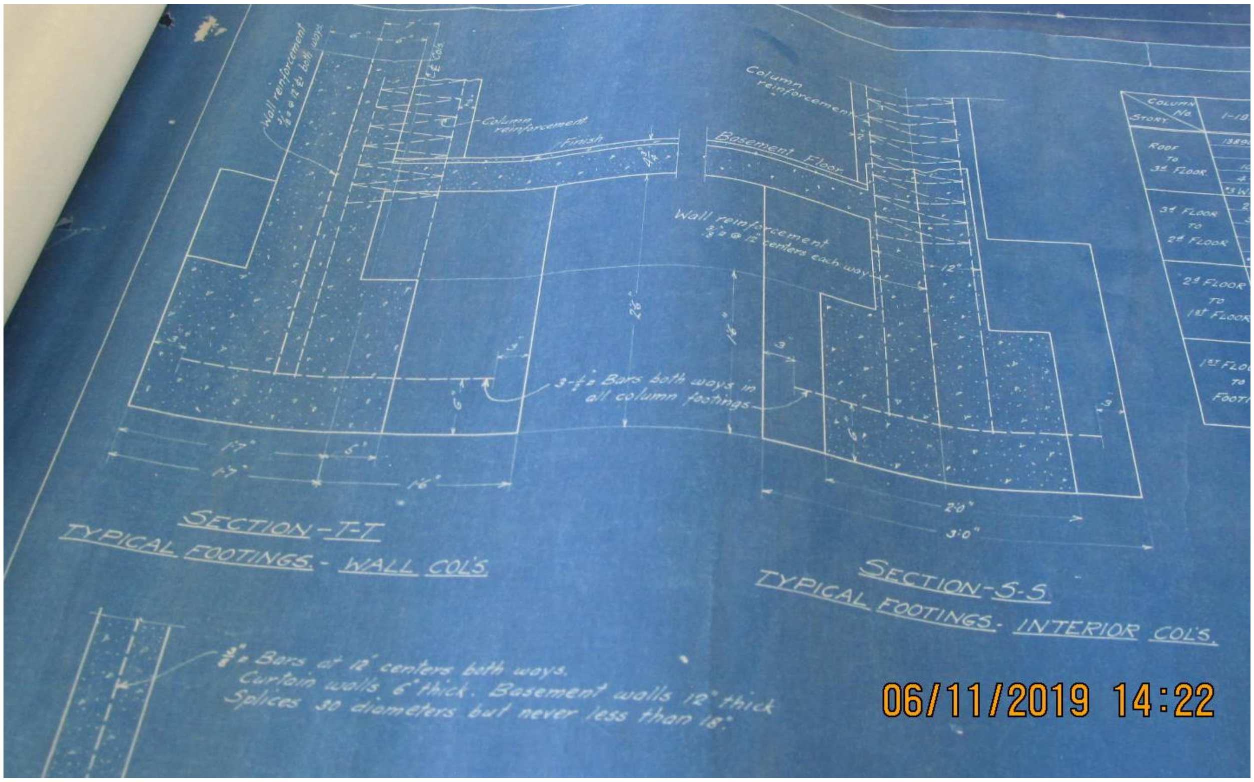


Typical Section Through Beams and Slab

Typical Connection of Beams and Slabs



Typical Column Footing Details



APPENDIX A

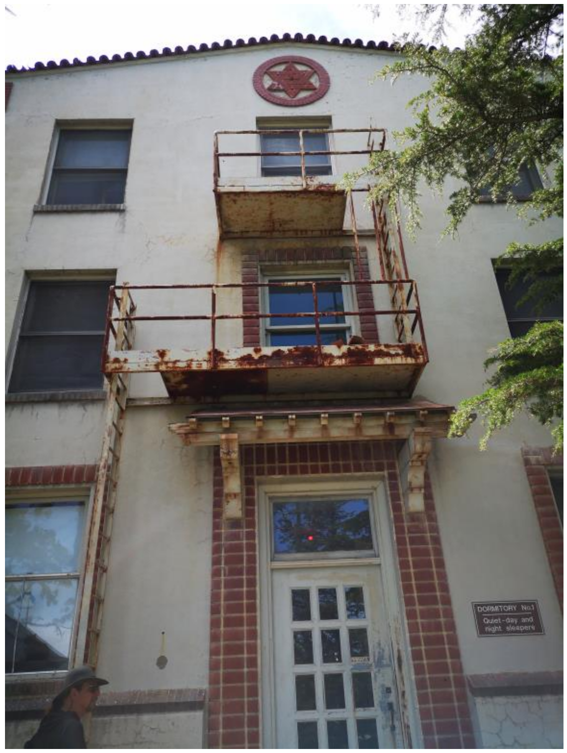
Additional Photos

Southwest Corner (Looking Northeast)

West Elevation (Looking East)

Northwest Corner (Looking Southeast)

North Elevation (Looking Northwest)

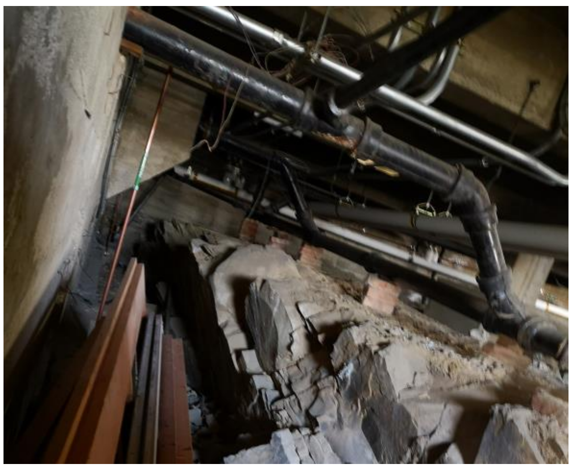


Partial East Elevation (Looking West).
Note Corrosion on the East Fire Escape

South Elevation (Looking Northwest)

Interior Corridor of Level 3

Tapered Column End in Basement

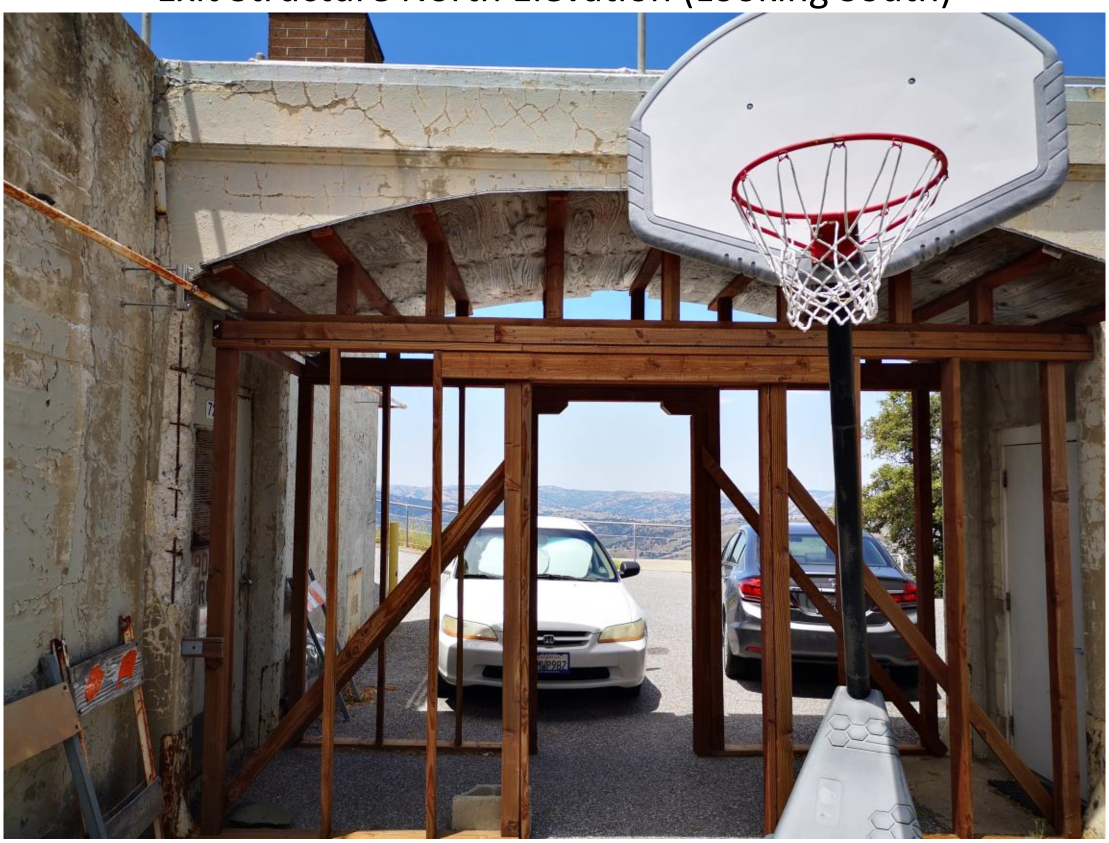


Crawl Space
Left Image: Basement Wall on the Left;
Right: Spread Footings under Columns Founded on Native Fractured Rock

Spalling and Corrosion at North Balcony

Underside of Roof Structure Above Third Story Ceiling

Exit Structure North Elevation (Looking South)



Exit Structure South Elevation (Looking North)

Message on Entrance to Dorm Reminding Visitors of One of the Implications of the Unusual Hours of Operation of an Observatory

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	Santa Cruz			Date:	07/29/2019	
Building CAAN:	7213	Auxiliary CAAN:		By Firm:	Rutherford + Chekene	
Building Name:	Mt Hamilton Dorm #1			Initials:	JY	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Rd, Mt Hamilton, CA 95140			Page:		of

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

C / NC / N/A / U	Description
NC	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. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1) **Comments:** Roof diaphragms deliver loads to perimeter concrete shear wall. However, the connection between the two is not well defined in the drawings.
NC	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. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2) **Comments:** The building is connected rigidly by the west exit structure to the adjacent retaining walls at the site retaining wall supporting the parking and drive aisle east of the Lab and Measurement Building.
N/A	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3) **Comments:** There are no mezzanines.

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C / NC / N/A / U	Description
C	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. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1) **Comments:** Same reinforcement, openings and wall thicknesses in the perimeter concrete shear wall is used at the third, second and first stories, and the basement walls are thicker.
C	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. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2) **Comments:** Same reinforcement, openings and wall thicknesses in the perimeter concrete shear wall is used at the third, second and first stories, and the basement walls are thicker.

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz			Date:	07/29/2019	
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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

C NC N/A U	
C (selected)	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3) **Comments:** All concrete shear walls continue to the strip footing foundations.
C (selected)	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. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4) **Comments:** Same perimeter concrete shear walls at each story.
C (selected)	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. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5) **Comments:** No major change in story mass at any story.
C (selected)	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. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6) **Comments:** The center of rigidity and center of mass for this building are very close in this symmetric, rectangular building by inspection.

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

GEOLOGIC SITE HAZARD

	Description
C NC N/A U C (selected)	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 (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1) **Comments:** Site is rocky and on top of a mountain. Liquefaction potential is judged by inspection to be negligible.
C NC N/A U C (selected)	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. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1) **Comments:** Engineering judgement given the building site at the base of the building is relatively level, and there is a retaining wall at the slope to the west.

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

GEOLOGIC SITE HAZARD

C NC N/A U	
● C ○ NC ○ N/A ○ U	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1) **Comments:** The Earthquake Zones of Required Investigation Lick Observatory Quadrangle map has no Earthquake Fault Zones near Mt. Hamilton. The Mt. Hamilton area was “not valuated for liquefaction or landslides.” See http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/LICK_OBSERVATORY_EZRIM.pdf

HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR MODERATE SEISMICITY)

FOUNDATION CONFIGURATION

	Description
○ 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 $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3) **Comments:** Building width B = 40’, Building average height is H = 42, B/H = 0.96 Sa = 1.87g per SEAOC at BSE-2E 0.6 x Sa = 1.12 B/H < 0.6 Sa
● 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. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4) **Comments:** Site Class B assumed.

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

Low And Moderate Seismicity

Seismic-Force-Resisting System

C NC N/A U	Description
○ ● ○ ○ (NC)	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:** The perimeter concrete walls are required to provide vertical supports as bearing walls.
● ○ ○ ○ (C)	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:** There are at least 2 lines of walls in each direction.
○ ● ○ ○ (NC)	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:** Calculated wall stresses exceed the ASCE 41 limit of 100 psi for f'c = 1,000 psi – wall average shear stresses in some stories in the transverse direction. Demands in the longitudinal direction (E-W) are 37, 71, 95, and 47 psi in the third, second, first, and basement stories, respectively. Demands in the transverse direction (N-S) are 69, 121, 136, and 50 psi, respectively..
● ○ ○ ○ (C)	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:** Per wall section details in Sheet No. S-1, at a minimum, ρ= 0.002 (3/8" square bars @ 12" o.c., e.w. in 6" thick walls and in 12" thick walls).

Connections

C NC N/A U	Description
○ ○ ● ○ (N/A)	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:** Building has rigid diaphragms.
○ ○ ○ ● (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:** The connection between the concrete diaphragm and the shear walls is not clear.

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz		Date:	7/29/2019	
Building CAAN:	7213	Auxiliary CAAN:	By Firm:	RUTHERFORD + CHEKENE	
Building Name:	Mt Hamilton Dorm #1		Initials:	JY	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Rd, Mt Hamilton, CA 95140		Page:	25	of 36

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:** The wall reinforcement is not hooked into the footings.

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

Seismic-Force-Resisting System

C	NC	N/A	U	Description
●	○	○	○	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:** All columns are either reinforced with #3 stirrups at 3" o.c. or #3 spirals with 3" pitch. Calculation shows that the columns have enough shear capacity to develop their flexural strength.
○	○	●	○	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:** There are no flat slabs.
○	○	●	○	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:** There are no coupling beams.

Diaphragms (Stiff Or Flexible)

C	NC	N/A	U	Description
●	○	○	○	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:** There are no split levels.
○	●	○	○	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:** There is a stair opening in the roof diaphragm in the west side of the building and the width is more than 25% of the wall length.

Flexible Diaphragms

	Description

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz			Date:	7/29/2019	
Building CAAN:	7213	Auxiliary CAAN:		By Firm:	RUTHERFORD + CHEKENE	
Building Name:	Mt Hamilton Dorm #1			Initials:	JY	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Rd, Mt Hamilton, CA 95140			Page:	26	of 36

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

C NC N/A U	
N/A	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** Building has rigid diaphragms.
N/A	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:** Building has rigid diaphragms.
N/A	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:** Building has rigid diaphragms.
N/A	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:** Building has rigid diaphragms.
N/A	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:** Building has rigid diaphragms.

Connections

	Description
C NC N/A U: N/A	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:** There are no pile caps.

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	Santa Cruz		Date:	07/28/2019	
Building CAAN:	7213	Auxiliary CAAN:	By Firm:	Rutherford + Chekene	
Building Name:	Mt Hamilton Dorm #1		Initials:	JY	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Rd, Mt Hamilton, CA 95140		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:** Ornamentation on the exterior wall near the roof is present and its anchorage back to the building is unknown. The loose roof tiles have tie wires, but wires are reportedly corroding. Severely deteriorated balconies pose a falling hazard to pedestrians below.
P ☐ **N/A** ☒	**Unrestrained hazardous material storage** **Comments:**
P ☒ **N/A** ☐	**Masonry chimneys** **Comments:** Masonry chimney observed on site outside by the exit structure.
P ☒ **N/A** ☐	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:** Natural gas-fueled equipment observed with no anchorage to the concrete pad below at their support legs. Instead, cable restrainers were provided in the transverse direction to resist transverse movement. They will provide limited resistance in the longitudinal direction.

Falling Hazards Risk: Moderate

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

APPENDIX D

Quick Check Calculations

Unit Weights:

Joists & Beams

Rectangular Sections

γ concr = 150 pcf

Girder ID	Length (ft)	B (in)	D (in)	Number	Area (ft^2)	Unit weight (pcf)	Weight (plf)	Weight (kips)
Beam-1	12	10	18	24	30.00	150.00	4500.0	54.00
Beam-2	15.83	10	18	7	8.75	150.00	1312.5	20.78
Beam-3	7.17	10	15	1	1.04	150.00	156.3	1.12
Beam-4	6.83	10	20	1	1.39	150.00	208.3	1.42
Beam-5	6.83	10	12	3	2.50	150.00	375.0	2.56
Girder	16	12	20	12	20.00	150.00	3000.0	48.00

Σ = 127.9 kips

Atrib = 2,600 ft2

w_total 49.2 psf

COLUMNS

Rectangular Sections

γ concr = 150 pcf

1st Level to 4th Level						
Col type	B (in)	H (in)	Area (ft^2)	Number	Unit weight (pcf)	Weight (plf)
14x14	14	14	1.36	25	150	5104.2
12x12	12	12	1.00	25	150	3750.0
10x10	10	10	0.69	25	150	2604.2
					Σ =	11458.3 plf

Level	Height (ft)	Col weight below (kips)	Trib Weight (kips)	Trib Area (ft2)	Trib Weight (psf)
Roof Level	10.17	26.5	13.2	2600.0	5.1
3rd Floor	10.58	39.7	33.1	2600.0	12.7
2nd Floor	10.58	54.0	46.8	2600.0	18.0
1st Floor	8.92	45.5	49.8	2600.0	19.1

Flat Load Tables

	Seismic Weight	Dead Load	
Roof Level	**psf**	**psf**	**Remarks**
Roofing	5	5	
Roof slab	38	38	3" slab
Beams and Girders	49	49	CIP Beams and Girders
Ceilings, sprinklers, lighting, MEP and misc.	5	5	
Partitions	5	0	
10"x10" Columns	5	0	RC columns
Total-typical roof	107	97	

3rd Level	**psf**	**psf**	**Remarks**
Slab and flooring	58	58	3.5" slab + 0.5" topping + 8 psf flooring (carpet & wood floor)
Beams and Girders	49	49	CIP Beams and Girders
Ceilings, sprinklers, lighting, MEP and misc.	5	5	
Partitions	10	10	
Columns	13	10	RC columns
Total-typical roof	135	132	

2nd Level	**psf**	**psf**	**Remarks**
Slab and flooring	58	58	3.5" slab + 0.5" topping + 8 psf flooring (carpet & wood floor)
Beams and Girders	49	49	CIP Beams and Girders
Ceilings, sprinklers, lighting, MEP and misc.	5	5	
Partitions	10	10	
Columns	18	15	RC columns
Total-typical roof	140	137	

1st Level	**psf**	**psf**	**Remarks**
Slab and flooring	58	58	3.5" slab + 0.5" toppping + 8 psf flooring (carpet&floor)
Beams and Girders	49	49	CIP Beams and Girders
Sprinklers, lighting, MEP and misc.	5	5	MEP hung from underside of floor slab
Partitions	10	10	
Columns	19	21	RC columns
Total-typical roof	141	143	

Story Weights

EXTERIOR CONTINUOUS WALLS

Story	Direction	Wall ID	Thickness (in)	Length (ft)	Area (ft^2)
4	X	4W - X	6	100	50.00
3	X	3W - X	6	98.75	49.38
2	X	2W - X	6	97	48.50
1	X	1W - X	12	112	112.00
					259.88

			Rectangular Sections		
Level	Direction	Wall ID	Thickness (in)	Length (ft)	Area (ft^2)
4	Y	4W - Y	6	54	27.00
3	Y	3W - Y	6	57.75	28.88
2	Y	2W - Y	6	68	34.00
1	Y	1W - Y	12	105	105.00
					194.88

Summary

Level	Height (ft)	Horizontal Area (ft^2)		
		X-direction	Y-direction	Grand total
Roof Level	10.17	50	27	77
3rd Level	10.58	49	29	78
2nd Level	10.58	49	34	83
1st Level	8.92	112	105	217

Story Weight

Floor Levels	Floor Area (ft^2)	Floor Weight (psf)	Wall Weight				
			Wall height below floor level (ft)	Wall height tributary to each floor level (ft)	Wall Area below (ft^2)	Wall Seismic Weight (kips)	Total Seismic Weight (kips)
Parapet			3.00		145		
Roof Level	2,600	107	10.17	8.09	77	143	420
3rd Level	2,600	135	10.58	10	78	139	490
2nd Level	2,600	140	10.58	11	83	147	511
1st Level	2,600	141	8.92	10	217	242	610
						Total Weight =	**2,031**

Notes:
1 - Seismic base is set at the basement level.
2 - Wall seismic weight has a factor of 1.15 to account for small spandrels above and below windows and glazing.
wconcrete = 150 psf

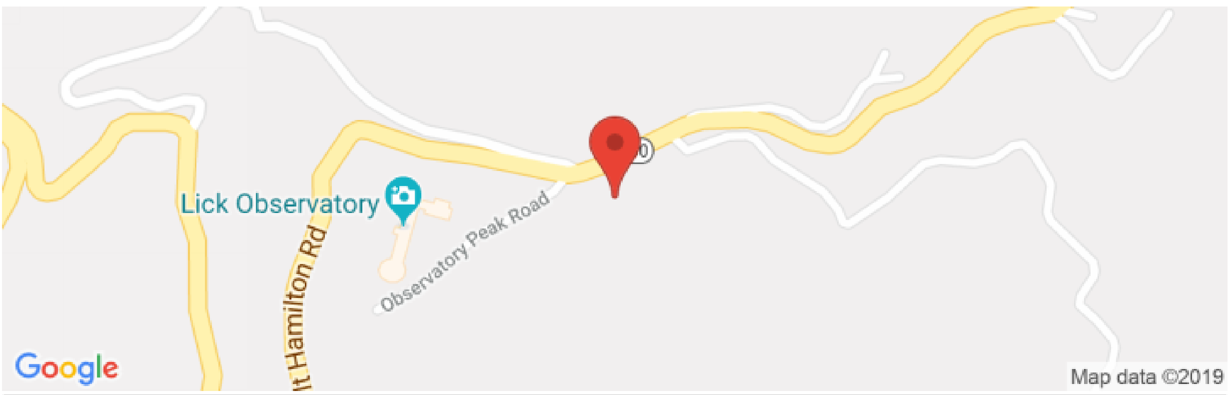
Period

C_t=	0.02
h_n (ft)=	42.00
B=	0.75

T=	0.33	sec

BSE-2E Response Spectrum

Latitude, Longitude: 37.341725, -121.640540



Date	6/25/2019, 2:39:09 PM
Design Code Reference Document	ASCE41-17
Custom Probability	
Site Class	B - Rock

Type	Description	Value
Hazard Level		BSE-2E
S_S	spectral response (0.2 s)	2.216
S_1	spectral response (1.0 s)	0.78
S_{XS}	site-modified spectral response (0.2 s)	1.682
S_{X1}	site-modified spectral response (1.0 s)	0.549
f_a	site amplification factor (0.2 s)	0.9
f_v	site amplification factor (1.0 s)	0.8

Seismic Force Distribution

Sa=	1.66	
W=	2,031	kips
C=	1.0	Per ASCE 41-17 Table 4-7

	Sx1	T	Sxs
BSE 2E	0.549	0.33	1.682

Sx1 / T = 1.66

V=	3,379	kips

k= 1.00

Per ASCE 41-17 Section 4.4.2.2, K = 1.0 for periods less than 0.5 sec and K = 2.0 for T >2.5 sec. It varies linearly in between 0.5 sec and 2.5 sec period.

Floor Levels	Story Height	Total Height, H	Weight, W	W x H^k	coeff	Fx	Story Shear, V
	(ft)	(ft)	(kips)			(kips)	(kips)
Roof Level	10.17	40.25	420	16,913	0.36	1,215	1,215
3rd Level	10.58	30.08	490	14,730	0.31	1,058	2,272
2nd Level	10.58	19.50	511	9,969	0.21	716	2,988
1st Level	8.92	8.92	610	5,438	0.12	391	3,379
Basement				47,050	1	3,379	

Notes:
1- The base of building is assumed to be at the basement.
2- Modification Factor, C, per ASCE 41-17, Table 4-7.

Table 4-7. Modification Factor, *C*

	Number of Stories			
Building Type[a]	**1**	**2**	**3**	**≥4**
Wood and cold-formed steel shear wall (W1, W1a, W2, CFS1) Moment frame (S1, S3, C1, PC2a)	1.3	1.1	1.0	1.0
Shear wall (S4, S5, C2, C3, PC1a, PC2, RM2, URMa) Braced frame (S2) Cold-formed steel strap-brace wall (CFS2)	1.4	1.2	1.1	1.0
Unreinforced masonry (URM) Flexible diaphragms (S1a, S2a, S5a, C2a, C3a, PC1, RM1)	1.0	1.0	1.0	1.0

[a] Defined in Table 3-1.

Average Stress:

Average Stresses

Ms = 4.5

f'c = 2000 psi

Average from 1976 concrete tests as reported in 1998 seismic evaluation by Wildman & Morris

Longitudinal (E-W direction)					
Story	Story Shear	Wall Area	Average Shear Stress	Tier 1 Shear Stress Limit	Wall OK?
	(kips)	(in^2)	(psi)	(psi)	
Roof Level - 3rd Level	1,215	7,200	37	100	OK
3rd Level - 2nd Level	2,272	7,110	71	100	OK
2nd Level - 1st Level	2,988	6,984	95	100	OK
1st Level - Basement	3,379	16,128	47	100	OK

Transverse (N-S direction)					
Story	Story Shear	Wall Area	Average Shear Stress	Tier 1 Shear Stress Limit	Wall OK?
	(kips)	(in^2)	(psi)	(psi)	
Roof Level - 3rd Level	1,215	3,888	69	100	OK
3rd Level - 2nd Level	2,272	4,158	121	100	NG
2nd Level - 1st Level	2,988	4,896	136	100	NG
1st Level - Basement	3,379	15,120	50	100	OK

Notes:

1 - Ms factor per ASCE 41-17 Table 4-8.

Table 4-8. M_s Factors for Shear Walls

	Level of Performance		
Wall Type	CP[a]	LS[a]	IO[a]
Reinforced concrete, precast concrete, wood, reinforced masonry, and cold-formed steel	4.5	3.0	1.5
Unreinforced masonry	1.75	1.25	1.0

[a] CP = Collapse Prevention, LS = Life Safety, IO = Immediate Occupancy.

COLUMN DEFORMATION COMPATIBILTY (0.9DL)

Material properties

- Concrete	f'_c	2	ksi	Average from 1976 concrete tests as reported in 1998 seismic evaluation by Wildman & Morris
- Steel rebar, longitui	f_y	33	ksi	Structural grade default per ASCE 41-17 for 1912 construction date.

Other parameters

- Flexural ductility	k_{nl}	0.7
- Normal weight	λ	1.0

spColumn Model	Level	SIZE			LONGITUDINAL			TRANVERSE				DIMENSION				CONFINEMENT		FLEX. YIELD		
		b (in)	h (in)	A_G (in²)	n-#	square bar size	A_S (in²)	n-#-s (in)	D (in)	A_v (in²)	$f_{y,t}$ (ksi)	d (in) [1]	h_b (in)	L (ft)	L_n (in)	s/d	a_{col}	$L_u/2d_c$	M_u/V_ud	$6f^{0.5}/(M/Vd)$
Column 8-X	1	14	14	196.0	8	0.75	4.5	2.0 #3 3	0.38	0.22	33	11.20	12.0	8.92	95.0	0.27	1.0	4.2	4.0	0.07
Column 8-Y	1	14	14	196.0	8	0.75	4.5	2.0 #3 3	0.38	0.22	33	11.20	12.0	8.92	95.0	0.27	1.0	4.2	4.0	0.07

spColumn Model	Level	AXIAL					SHEAR					FLEXURE					ADDITIONAL CHECK (LIMITED BY DRIFT)					
		N_{UG} (k) [2]	x (ft)	y (ft)	A_{trib} (ft²)	$(1+N/6Af^{0.5})^{0.5}$	V_S (k) [3]	$V_{S,full}$ (k)	V_C (k)	V_{col} (k) [4]	$V_{col,moderate}$ (k) [2]	M_{P-D} (k-ft) [5]	M (k-ft) [5]	2M/L (k)	SHEAR/FLEX. CONTROL	Vp/Vcol	E (ksi)	I_g (in⁴)	Δ (in)	L (in)	Vprob (k) [6]	Acceptance criteria [7]
Column 8-X	1	78	13.9	11.7	162.2	1.6	27.2	27.2	16.6	30.7	30.7	71.0	67.0	16.9	Flexure	0.55	2549.1	1,639.1	0.5	107.0	10.2	-
Column 8-Y	1	78	13.9	11.7	162.2	1.6	27.2	27.2	16.6	30.7	21.1	71.0	67.0	16.9	Flexure	0.55	2549.1	1,639.1	0.5	107.0	10.2	-

Notes:

1 - Effective depth, d, is computed as 0.8h, where h is the dimension of the column in the direction of shear.

2 - Based on 0.9DL.

3 - Per 10.3.4/ASCE 41-17, lap-spliced reinforcement in tied columns is assumed to be ineffective in regions of high ductility demand.

4 - Shear capacity of column is based on ASCE 41-17 Eq 10-3 using nominal material strengths with $\phi = 1.0$.

$$V_{col} = k_{nl} \cdot \left[\alpha_{col} \cdot \left(\frac{A_v \cdot f_{ytLE} \cdot d}{s} \right) + \lambda \cdot \left[\sqrt{1 + \frac{N_{UG}}{6 \cdot Ag \cdot \sqrt{f_{cLE}}}} \cdot \frac{6 \cdot (f_{cLE})}{\left(\frac{M_{UD}}{V_{UD} \cdot d} \right)} \right] \cdot 0.8 \cdot A_g \right]$$

α_{col} = 1.0 for s/d <= 0.75, 0.0 for s/d >=1.0

5 - Plastic moment capacity of the column is based upon expected flexural strength using tested average for f'c and 1.25 fy.

6 - Shear induced due to drift of a fixed-fixed column.

$$V_{prob} = \frac{12E \cdot 0.5 \cdot I_g \cdot \Delta}{L^3}$$

7- Vprob is compared to Vcol. If Vprob <Vcol, Shear failure is not likely to occur.

COLUMN DEFORMATION COMPATIBILTY (1.1DL+0.275LL)

Material properties

- Concrete	f'_c	2	ksi	Average from 1976 concrete tests as reported in 1998 seismic evaluation by Wildman & Morris
- Steel rebar, longitudinal reba	f_y	33	ksi	Structural grade default per ASCE 41-17 for 1912 construction date.

Other parameters

- Flexural ductility	k_{nl}	0.7
- Normal weight	λ	1.0

spColumn Model	Level	SIZE			LONGITUDINAL		TRANVERSE						DIMENSION				CONFINEMENT		FLEX. YIELD			AXIAL					SHEAR					FLEXURE			SHEAR/FLEX. CONTROL		ADDITIONAL CHECK (LIMITED BY DRIFT)					
		b (in)	h (in)	A_g (in²)	n-#	D (in)	n-#-s (in)			D (in)	A_v (in²)	f_{yt} (ksi)	d (in) [1]	h_b (in)	L (ft)	L_u (in)	s/d	a_{col}	$L_u/2d_c$	M_u/V_ud	$6f^{0.5}/(M/Vd)$	N_{UG} (k) [2]	x (ft)	y (ft)	A_{trib} (ft²)	$(1+N/6Af^{0.5})^{0.5}$	V_s (k) [3]	$V_{S,full}$ (k)	V_C (k)	V_{col} (k) [4]	$V_{col,moderate}$ (k) [2]	M_{P-D} (k-ft) [5]	M (k-ft) [5]	2M/L (k)		Vp/Vcol	E (ksi)	I_g (in⁴)	Δ (in)	L (in)	Vprob (k) [6]	Acceptance criteria [7]
Column 8-X	1	14	14	196.0	8	0.75	2.0	#3	3	0.38	0.33	33	11.20	12.0	10.17	110.0	0.27	1.0	4.9	4.0	0.07	98	13.9	11.7	162.2	1.7	40.8	40.8	17.8	41.1	41.1	71.0	67.0	14.6	Flexure	0.36	2549.1	1,639.1	0.5	122.0	6.9	-
Column 8-Y	1	14	14	196.0	8	0.75	2.0	#3	3	0.38	0.33	33	11.20	12.0	10.17	110.0	0.27	1.0	4.9	4.0	0.07	98	13.9	11.7	162.2	1.7	40.8	40.8	17.8	41.1	26.8	71.0	67.0	14.6	Flexure	0.36	2549.1	1,639.1	0.5	122.0	6.9	-

Notes:

1 - Effective depth, d, is computed as 0.8h, where h is the dimension of the column in the direction of shear.

2 - Based on 1.1DL+0.275LL.

3 - Per 10.3.4/ASCE 41-17, lap-spliced reinforcement in tied columns is assumed to be ineffective in regions of high ductility demand.

4 - Shear capacity of column is based on ASCE 41-17 Eq 10-3 using nominal material strengths with φ =1.0.

$$V_{col} = k_{nl}\left[\alpha_{col}\left(\frac{A_v \cdot f_{ytLE} \cdot d}{s}\right) + \lambda\left[\sqrt{1+\frac{N_{UG}}{6 \cdot Ag \cdot \sqrt{f_{cLE}}}} \cdot \frac{6(f_{cLE})}{\left(\frac{M_{UD}}{V_{UD} \cdot d}\right)}\right] 0.8 \cdot A_g\right]$$

α_{col} = 1.0 for s/d <= 0.75, 0.0 for s/d >=1.0

5 - Plastic moment capacity of the column is based upon expected flexural strength using tested average for f'c and 1.25 fy.

6 - Shear induced due to drift of a fixed-fixed column.

$$V_{prob} = \frac{12E \cdot 0.5 \cdot I_g \cdot \Delta}{L^3}$$

7- Vprob is compared to Vcol. If Vprob <Vcol, Shear failure is not likely to occur.