Rating form completed by: **MAFFEI STRUCTURAL ENGINEERING**
maffei-structure.com
Noelle Yuen, Joe Maffei

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

Hahn Art Facility, University of California Santa Cruz

CAAN #7199
521 Cowell-Stevenson Road, Santa Cruz, CA 95064
UCSC Campus: Main Campus

REGISTERED PROFESSIONAL ENGINEER JOSEPH RICHARD MAFFEI No. 3694 STRUCTURAL STATE OF CALIFORNIA

DATE: 2018-12-31

Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating basis	2018	
Recommended list assignment (UC Santa Cruz 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]	Medium ($50 - $200/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	No previous rating reported
Further evaluation recommended?	Tier 2	

[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

- Original construction drawings with title block "University of California Physical Planning and Construction" and designer "C.O.M", titled "Student Facilities Art," dated 1968-7-27 and 1969-1-16 (5 sheets with architectural, structural, MEP drawings).
- As-built construction drawings for renovation and expansion with title block "University of California Office of Campus Facilities" by designer "R.P.A." and drawn by "F.M.Z.", titled "Hahn Art Facilities Alteration," dated 1981-9-25 (6 sheets with architectural, structural, MEP drawings). (We speculate that these initials may reference Richard Peterson Architects, and Frank Zwart.)
- University of California building database information, "Hahn Art Facility," provided by Jose Sanchez (UCSC) on 2018-11-20.

Additional building information known to exist

- None

Scope for completing this form

We reviewed structural drawings for original construction and renovation and carried out an ASCE 41-17 Tier 1 evaluation. We did not make site visit or evaluate non-structural life-safety hazards but reviewed photos by UCSC staff.

Brief description of structure

The building is a wood structure, one story above grade, and has an area of approximately 3,369 square feet. It was designed in 1968, most likely by the campus architect. Construction was completed in 1968. The floor plate is rectangular in plan, with dimensions 40 ft north-south by 80 ft east-west. (Prior to a 1981 renovation, the enclosed portion of the building was 24 ft north-south by 80 ft east-west.) A clerestory window is provided over the full length of the north wall, with a window height of about 19 ft, located just below the roof eave.

In 1981, the building was renovated, and most of the original south exterior wall was removed and rebuilt 16 feet to the south to enclose an existing breezeway and increase the interior area of the building (see attached floor plan). On the line of the south wall that was removed, new glulam beams spanning to new wood posts were provided to support the roof rafters. New plywood sheathing was provided at both the portion of the original south wall that remained, and at the new exterior south wall.

Foundation System: The building is located on a hillside, with grade sloping downward from south to north. The building site itself is level, because of a retaining wall at the south (uphill) end of the building, which is structurally separate from the building and located approximately 3 feet uphill from the building wall. The north (downhill) end of the building bears on a concrete foundation wall, which is supported on 16-inch diameter cast-in-place drilled piers. This foundation wall is dowelled to a 4" slab-on-grade, which covers the entire building footprint. The slab-on-grade is thickened to 12" wide by 16" deep under the building walls. New spread footings were provided at four posts installed in the building renovation.

Structural system for vertical (gravity) load: The roof is framed with 2x12 rafters at 16" spacing, spanning north-south and bearing at three lines of support: the north exterior wall, the interior bearing walls and beams at the original south exterior wall (designated as "Line B" for the remainder of this report), and the south exterior wall. The ground floor is a 4" slab-on-grade.

Structural system for lateral forces: The roof is laterally supported on three sides by the wood framed shear walls at the west exterior wall, the east exterior wall, and the interior and exterior walls at the south side of the building. The roof is not laterally supported at the north side of the building because a clerestory window runs the length of the exterior north wall, providing no force path to the wall below the window. Walls are constructed with 2x6 studs and 3/8" or 1/2" plywood sheathing. The roof is unblocked, with 1/2" plywood sheathing.

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:

- The building may have significant plan-torsion response to earthquake ground shaking in the east-west direction, because of the eccentric wall layout, which locates all east-west walls at the south end of the building. The resulting plan torsion may cause increased stress at the east-west walls on Line B. The roof diaphragm is unblocked and may allow excessive in-plane displacement and the north wall that has the clerestory, although the diaphragm aspect ratio, with 80' depth mitigates this issue. Building code requirements since about 1980 have not permitted flexible wood diaphragms to resist plan torsion, as the roof diaphragm is called on to do in this structure.
- No continuous collector is provided at Line B, possibly leading to overstress at the connection of the roof diaphragm to the shear walls on Line B.
- Joists are lapped spliced over Line B with no straps installed to provide continuity at the splice, resulting in a lack of a continuous chord member at the east and west edges of the building. However, the low aspect ratio of the building diaphragm (depth = 80'), combined with the nailing of the joists to the plywood sheathing which serves to splice the joist together, indicate that this deficiency may not be critical.
- North-south walls at the south end of the building are relatively short in length (9' long) relative to the height of the roof (14' average height). Overturning moment demands at the base of the walls may be relatively high. No hold-down connections from the walls to their foundation are shown in the drawings.

The light mass of the building helps to mitigate the seismic deficiencies.

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)	Y
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)	N	URM wall height-to-thickness ratio	N
Torsion	Y	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]

The window at the north side of the building is approximately 12' tall x 80' long, and is located in elevation at the top of the north wall. Because the window slopes inward such that it is directly overhead the interior space, it appears that falling glass could pose a safety hazard in an earthquake, if the window is subjected to in-plane story drift demands that exceed the in-plane deformation capacities of the glass and frame. The structural deficiencies listed above may result in increased story drift over that typically seen in a building of this size, and thus may result in increased risk of window breakage.

[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	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

Discussion of rating

The potential risk posed by the large window, combined with expected plan torsion behavior and wall overturning, leads us to recommend a rating of V (Poor). We recommend that further study, such as a Tier 2 or Tier 3 analysis to confirm the rating. Such analysis might show acceptably low risk to life safety to allow a rating of IV (Fair).

Recommendations for further evaluation or retrofit

We recommend that the University perform a more detailed seismic evaluation to determine whether retrofitting is required. A Tier 2 linear analysis may be appropriate, including calculations to determine the expected story drift at the window wall. Applicable retrofit measures may include improving roof connectivity for chords and collectors, providing diagonal rod bracing under the roof diaphragm, providing plywood sheathing at the existing east-west interior walls, and/or augmenting hold-down capacity of walls.

Additional building data	Entry	Notes
Latitude	36.997982	
Longitude	-122.05272	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	1	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	3369	
Risk Category per 2016 CBC Table 1604.5	II	Educational occupancy (above 12th grade) but occupant load less than 500.
Estimated fundamental period	0.15 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Building structural height, h_n	14 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Defined per ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Defined per 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

[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:

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	1.29	
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: 1968 Code: 1967 UBC	Code inferred based on construction year
Applicable code for partial retrofit	Built: 1981 Code: 1979 UBC	Extent of retrofit (partial or full) unknown
Applicable code for full retrofit	None	-
FEMA P-154 data		
Model building type North-South	W1 Wood wall	
Model building type East-West	W1 Wood wall	
FEMA P-154 score	N/A	Not included here, ASCE 41 Tier 1 evaluation performed.
Previous ratings		
Most recent rating	-	No known previous rating
Date of most recent rating	-	
2nd most recent rating	-	
Date of 2nd most recent rating	-	
3rd most recent rating	-	
Date of 3rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file

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.

Figure: Annotated floor plan

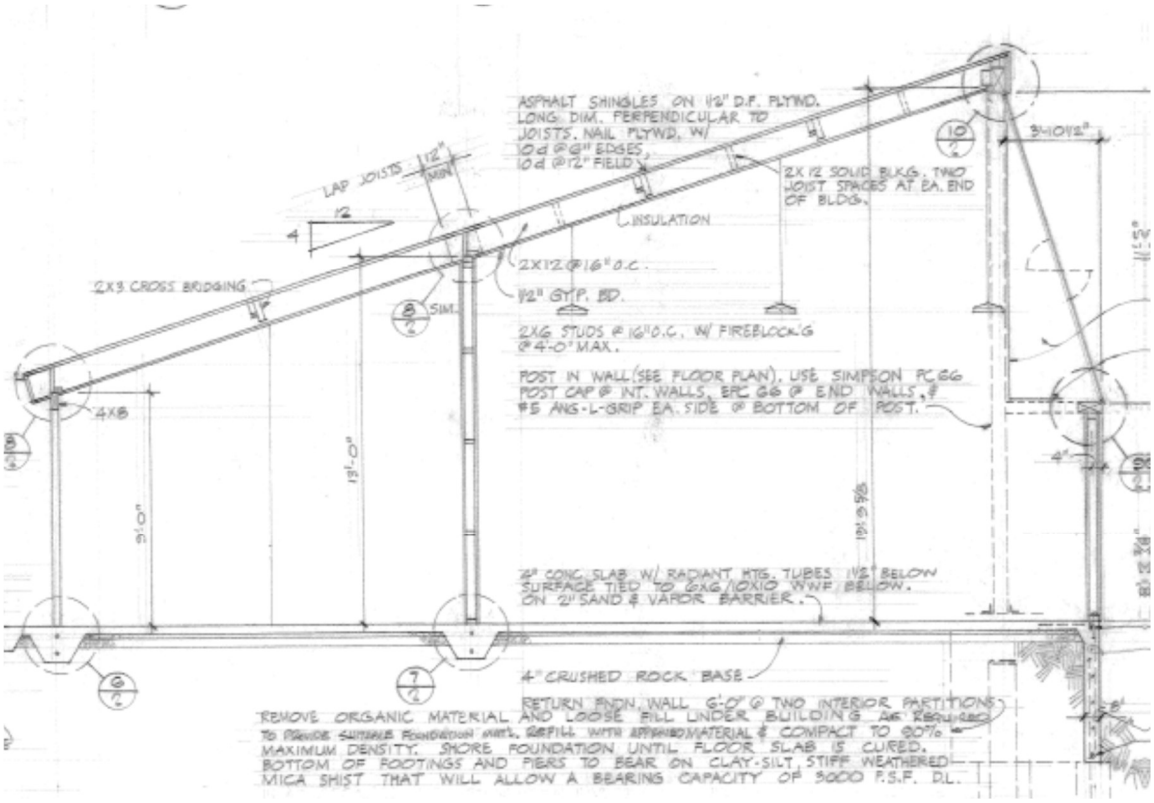

Figure: Building section

Figure: West elevation

Figure: South elevation

Figure: North elevation

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

	Description
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. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1) **Comments: C –** load path from north roof edge to north perimeter wall is interrupted by full-length window at the north side of the building; however complete load path for roof lateral load is provide by support of roof on three sides by walls at east, west, and south perimeters (plus interior walls at south).
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. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2) **Comments: C** – no adjacent buildings
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. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3) **Comments: N/A –** no mezzanine level

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

	Description
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. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1) **Comments: N/A –** one-story building
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. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2) **Comments: N/A –** one-story building

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

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C	NC	N/A	U	
●	○	○	○	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: C –** all walls are continuous to foundation
○	○	●	○	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: N/A –** one-story building
○	○	●	○	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: N/A –** one-story building
○	●	○	○	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: N/C –** does not conform for lateral forces in the east-west direction.

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

GEOLOGIC SITE HAZARD

C	NC	N/A	U	Description
●	○	○	○	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: C**
○	○	○	●	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: U –** building is built into a slope so it is potentially affected by slope failure. Drilled piers exist under the downhill (north) perimeter wall and a slab on grade covers the entire floor plan.

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

GEOLOGIC SITE HAZARD

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: C**

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

FOUNDATION CONFIGURATION

C	NC	N/A	U	Description
○	●	○	○	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: NC –** least horizontal dimension occurs at electrical room north-south wall, L=8' and h= 14.3'. L/h = 0.55 < 0.6Sa = 0.6*1.55 = 0.93
●	○	○	○	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: C –** Foundation under majority of building consists of slab on grade, thickened under walls. Piers at north side of building tied to rest of building with 4" slab on grade over building footprint.

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type W1-W1A

LOW AND MODERATE SEISMICITY

SEISMIC-FORCE-RESISTING SYSTEM

	Description
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**
C NC N/A U ● ○ ○ ○	SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the following values: (Commentary: Sec. A.3.2.7.1. Tier 2: Sec. 5.5.3.1.1) Structural panel sheathing: 1,000 lb/ft (14.6 kN/m) Diagonal sheathing: 700 lb/ft (10.2 kN/m) Straight sheathing: 100 lb/ft (1.5 kN/m) All other conditions: 100 lb/ft (1.5 kN/m) **Comments: C –** Avg. v,north-south walls = 485 #/ft < 1000 #/ft, OK Avg. v, east-west walls = 758 #/ft < 1000#/ft, OK. Actual stress may be higher due to plan torsion.
C NC N/A U ○ ○ ○ ○	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.7.2. Tier 2: Sec. 5.5.3.6.1) **Comments: N/A** – one-story building
C NC N/A U ○ ○ ○ ○	GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used for shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.7.3. Tier 2: Sec. 5.5.3.6.1) **Comments: N/A** – one-story building
C NC N/A U ○ ○ ○ ○	NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4. Tier 2: Sec. 5.5.3.6.1) **Comments: C –** At south interior wall, h = 13.6', L = 7', h/L = 1.9 < 2 OK At south perimeter wall, h = 9', L= 9', h/L = 1.0 < 2.0 OK

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Collapse Prevention Structural Checklist For Building Type W1-W1A

C	NC	N/A	U	
○	○	○	○	WALLS CONNECTED THROUGH FLOORS: Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.7.5. Tier 2: Sec. 5.5.3.6.2) **Comments: N/A** – one-story building
○	○	○	○	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-1. (Commentary: Sec. A.3.2.7.6. Tier 2: Sec. 5.5.3.6.3) **Comments: N/A –** building is on a slope, but shear walls are located away from downhill side.
○	○	○	○	CRIPPLE WALLS: Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.7.7. Tier 2: Sec. 5.5.3.6.4) **Comments: C** – no cripple walls
○	○	○	○	OPENINGS: Walls with openings greater than 80% of the length are braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.7.8. Tier 2: Sec. 5.5.3.6.5) **Comments: NC –** South perimeter wall and south interior east-west wall are both more than 80% open. South perimeter wall, h = 9', L= 9', h/L = 1.0 < 1.5, OK South interior wall, h = 13.6', L = 7', h/L = 1.9 > 1.5 AND positive ties are not provided. NC

CONNECTIONS

				Description
○	○	○	○	WOOD POSTS: There is a positive connection of wood posts to the foundation. (Commentary: Sec. A.5.3.3. Tier 2: Sec. 5.7.3.3) **Comments: C –** post caps provided top and bottom all posts
○	○	○	○	WOOD SILLS: All wood sills are bolted to the foundation. (Commentary: Sec. A.5.3.4. Tier 2: Sec. 5.7.3.3) **Comments: C –** bolts provided at 4' o.c. minimum
○	○	○	○	GIRDER-COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1) **Comments: C –** post caps provided top and bottom all posts

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

CONNECTIONS

	Description
C NC N/A U	WOOD SILL BOLTS: Sill bolts are spaced at 6 ft or less with acceptable edge and end distance provided for wood and concrete. (Commentary: Sec. A.5.3.7. Tier 2: Sec. 5.7.3.3) **Comments: C –** bolts provided at 4' o.c. minimum

DIAPHRAGMS

	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: C**
C NC N/A U	ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1) **Comments: NC –** joists are lap spliced over south interior east-west wall.
C NC N/A U	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: N/A** – plywood sheathed roof diaphragm
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. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments: C** – plywood sheathed roof diaphragm

UC Campus:	University of California Santa Cruz			Date:	12/14/2018		
Building CAAN:	7199	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Hahn Art Facility			Initials:	*NY*	Checked:	*JRM*
Building Address:	521 Cowell-Stevenson Road, Santa Cruz, CA 95064			Page:	4	of	4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type W1-W1A

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 m) and have aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments: C –** roof diaphragm appears unblocked but span is less than 40'.
C	**NC**	**N/A**	**U**	
○	○	○	○	OTHER DIAPHRAGMS: The 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: C**

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

SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General

Building	Hahn Art Facility (CAAN #7199)		**Reference**
Architect	Unknown		(UCSC database)
Structural Engineer	Unknown		(UCSC database)
Location	521 COWELL-STEVENSON ROAD, Santa Cruz, CA 95064		(UCSC database)
Design date	1968		(Construction dwgs dated 7/26/68)
Latitude	36.997982		(Google Earth)
Longitude	-122.05272		"
Stories above grade	1		

Seismic parameters

*MSE rule for establishing occupant load for risk category as follows. Assume 20 net sf/person per 2016 CBC table 1004.1.2 for "Educational classroom" function. Worst case, net area = gross area. Therefore, 3200 sf/20 = 160. Assume 160 occupants, less than 500, '

Risk Category	II	2016 CBC Table 1604.5		
Site Class	C	https://earthquake.usgs.gov/hazards/urban/sfbay/soiltype/		(ASCE 41-17 2.4.1.6, ASCE 7-16 Chapter 20)
Liquefaction hazard	Low	http://data-sccgis.opendata.arcgis.com/datasets/77d380d355934b38a44894154377e28d_62		(ASCE 41-17 3.3.4)
Landslide hazard	Low	http://data-sccgis.opendata.arcgis.com/datasets/7984aabd55ec4a4794ae33d7919bd9c7_133		
S_{DS}	1.312	https://hazards.atcoun	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-4)
S_{D1}	0.588	https://hazards.atcouncil.org/	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-5)
S_{XS}	1.286	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)
S_{X1}	0.885	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)

Scope

Performance level	Collapse Prevention	(ASCE 41-17 Table 2-2)
Seismic hazard level	BSE-2E	(ASCE 41-17 Table 2-2)
Level of seismicity	High	(ASCE 41-17 Table 2-4)
Building type	W1: Wood Light Frames	(ASCE 41-17 Table 3-1)

Material properties

				Notes	
Concrete	f'_c	3000	psi	Detault per ASCE 41 Table 4-2	(ASCE 41-17 Table 10-4)
Reinf.	f_y	40	ksi	Detault per ASCE 41 Table 4-3	(ASCE 41-17 Table 10-4)
Wood	F_y	unknown	ksi	No specifications in dwgs	(ASCE 41-17 Table 10-4)
Steel	F_y	N/A	ksi	N/A	(ASCE 41-17 Table 9-1)

Checklists

Benchmark building	No	(ASCE 41-17 Table 3-2)
Checklist(s) req'd	17.1.2 Basic Configuration	(ASCE 41-17 Table 4-6)
	17.12 Structural Checklist for Building Types W1	(ASCE 41-17 Table 4-6)
	~~17.19 Nonstructural Checklist~~ (not performed)	(ASCE 41-17 Table 4-6)

Seismic forces

V	182	kip	$V = Cs_a W$	= 1.67W	(ASCE 41-17 Eq 4-1)
W	109	kip	building weight		(ASCE 41-17 4.4.2.1)
C	1.3		Convert linear elastic to inelastic disp.		(ASCE 41-17 Table 4-7)
S_a	1.29	g	$S_a = S_{x1}/T \le S_{XS}$		(ASCE 41-17 Eq 4-3)
T	0.15	sec	$T = C_t h_n^{\beta}$		(ASCE 41-17 Eq 4-4)
C_t	0.020				(ASCE 41-17 Eq 4-4)
β	0.75				(ASCE 41-17 Eq 4-4)
h_n	14	ft	building height		(ASCE 41-17 Eq 4-4)

Story Forces (ASCE 41-17 4-2a) (ASCE 41-17 4-2b)

Story	w	story ht	h	wh^k	F_{story}	F_{story}	V_{story}
	kip	ft	ft			kip	kip
Roof	108.6	14	14	1556	1.00	182	
Total	109			1556	1.0	182	

k 1.00 k = 1.0 for T < 0.5, 2.0 for T > 2.5, linear interpolation between

$F_{story} = V(wh^k)/(\Sigma wh^k)$ (ASCE 41-17 4-2a)

$V_{story} = \Sigma_{above} F_{story}$ (ASCE 41-17 4-2b)

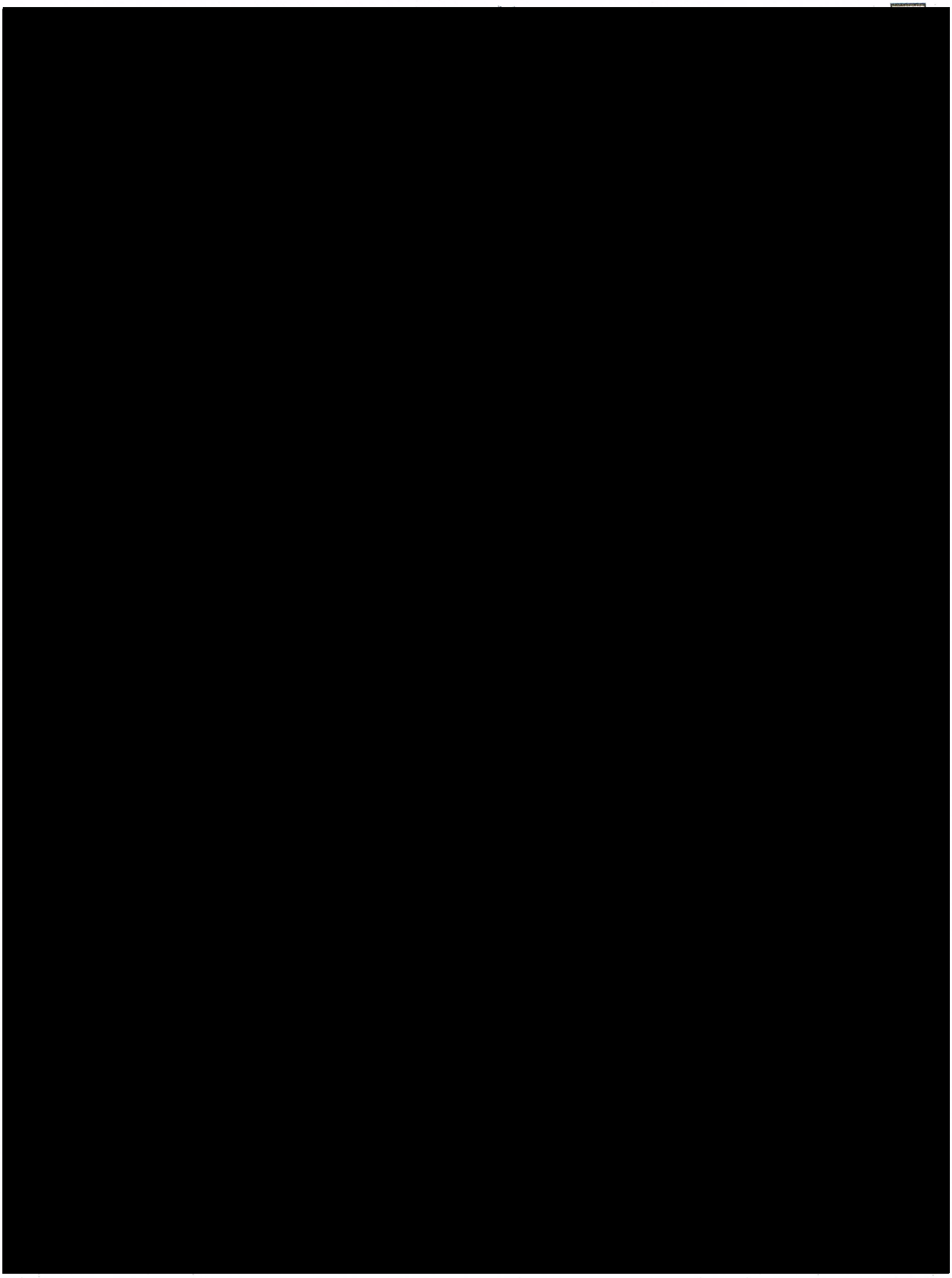
Shear stress in shear walls (ASCE 41-17 4-8) (ASCE 41-17 4-8)

Story	$L_{w\,N\text{-}S}$	$L_{w\,E\text{-}W}$	v_{NS}^{avg}	v_{EW}^{avg}	D/C_{NS}	D/C_{EW}
	lf	lf	#/lf	#/lf		
Roof	100	64	403	630	0.4	0.6
Total						

M_s 4.50 (ASCE 41-17 Table 4-8)

v_{limit} 1000 #/ft plywood sheathing

$v^{avg} = (1/M_s)(V_{story}/A_w)$ (ASCE 41-17 Eq 4-8)



HAHN ARTS

Seismic load table

		Seismic wght
ROOF	Asphalt shingle roof	2 psf
	½" plywood	1.6
	2x12 @ 16" joist	5
	2x12 @ 24" blkg	2
	insulation, MEP, gyp ceil	5
	½" gyp board	2.2
		17.8 × $\frac{\sqrt{12^2+4^2}}{12}$ slope = 18.7
	Partitions	5
		23.7 psf, say 24 psf

WALL Perimeter wall

2x6 @ 16" studs + ½" gyp + insulati + ⅜" plywood ≈ 12 psf

Weight of building

$$W = (24^{psf}_{roof})(40' \times 80') + (12^{psf}_{wall})\Big(\underbrace{80'\left(\frac{19.67'}{2}\right)}_{north} + \underbrace{40'(2)\left(\frac{9+19.67}{2}\right)}_{west+east} + \underbrace{80'(9')}_{south}\Big)$$

$$= 76800 + 31843$$

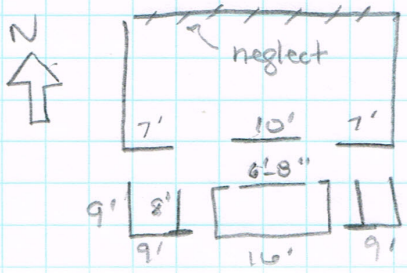
$$= 108.6\ k$$

Height of building

h_n = avg height of roof = $\frac{9+19.67}{2} = 14.3'$

Length of walls

- Neglect north wall (no connection to roof) + interior gyp walls



North-south $L = 24'(2) + 9'(4) + 8'(2)$

$= 100'$

East-west $L = 9'(2) + 7'(2) + 16' + 10' + 6'-8"$

$= 64'$