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

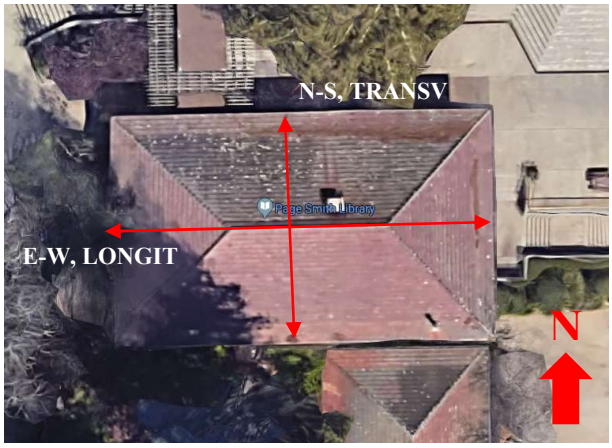
Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

UC Santa Cruz building seismic ratings

Cowell Library, University of California Santa Cruz

CAAN #7131
523 Cowell Service Road, Santa Cruz, CA 95064
UCSC Campus: Main Campus

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	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

- As-built architectural drawings by Wurster, Bernardi, and Emmons Architects (architect), "Residential College No. 1," dated 1966-12-12 (26 sheets).
- Structural drawings by Gilbert, Forsberg, Diekmann, Schmidt Civil and Structural Engineers (32 sheets, Cowell Library plans and elevations on sheet S15).
- University of California building database information, "Cowell College Library," provided by Jose Sanchez (UCSC) on 2018-11-20.

Additional building information known to exist

- None

Scope for completing this form

Reviewed structural drawings for original construction and carried out ASCE 41-17 Tier 1 evaluation. We made a brief site visit. We did not perform the Tier 1 nonstructural evaluation, but we looked for potentially hazardous nonstructural components during our site visit. No nonstructural hazards were identified.

Brief description of structure

Cowell Library is part of the Cowell College complex (formerly College One). The complex was designed in 1964 by the architectural office of Wurster, Bernardi and Emmons and the structural office of Gilbert-Forsberg-Diekman-Schmidt; construction was completed in 1966.

The building is a concrete wall structure with a wood roof, one story above grade, and has an area of approximately 3,987 square feet. There is a partial one-story basement at the southwest corner of the building. The floor plate is rectangular in plan, dimensioned 41 ft north-south by 76 ft east-west.

Foundation System: The building is on a slightly sloping site, sloping downhill from north to south. The foundation of the building consists of 18" wide concrete strip footings under the perimeter concrete walls and 26" x 26" concrete spread footings under interior wood posts. The partial basement occurs at the southeast corner of the building, with concrete perimeter walls bearing on strip footings.

Structural system for vertical (gravity) load: Wood framing is provided at the first floor and roof. The first floor is framed with 2x14 joists at 12" or 16" spacing. The joists span north-south over three bays, supported by the exterior north and south walls and two interior lines of 6x14 wood beams. The beams are supported by 6x6 wood posts that bear on concrete pedestals on concrete spread footings. The roof is framed with wood trusses spanning between the exterior north and south walls spaced at 8'-6" on center. The exterior walls have tall openings up to 8'-0" wide, and a 12"x12" concrete perimeter beam is provided at the top of the wall to ring the building and span across the window openings. The roof trusses support 6x10 and 6x14 beams which in turn support 2x6 rafters spaced at 24".

Structural system for lateral forces: 8" concrete perimeter walls are provided in both the east-west and north-south directions, continuous from roof to foundation. The roof diaphragm is sheathed with 5/8" plywood sheathing, the first floor is topped with 3/4" plywood sheathing.

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

Concrete wall piers have substantial strength and are expected to remain essentially elastic in-plane. Identified seismic deficiencies of the building include the following:

- Concrete walls are connected to the roof diaphragm at each roof truss with 2-3/4" diameter anchor bolts attaching the roof truss to the concrete wall. Preliminary calculations show that these bolts do not have adequate strength for the specified out-of-plane demands of the wall.
- At the hipped section of the roof, no straps are provided at the hips to provide continuous ties between the roof diaphragm chords.

- The wall openings on the north, east, and west walls, extend to within 12" of the top of wall thus reducing available height for a coupling beam over the wall openings. An existing 12" beam is provided at the top of the wall, but is lightly reinforced with only 4 #5 reinforcing bars, and no closed transverse ties. Additional analysis is required to determine whether deformation in the 12" x 12" coupling beams results in damage to the beams. Preliminary calculations show that the beams have adequate strength to support the roof trusses across the wall openings (assuming flexural yielding but not shear failure occurs in the beam) With the light reinforcement, damage to the beams could create a potential falling hazard from pieces of dislodged concrete.

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	Y	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	Y
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 non-structural life-safety concerns, including at exit routes.[3]

Potential falling hazards consists of the clay tile roof, and tall book shelves inside the library. We recommend that the anchorage of these items be inspected and evaluated.

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	Possibly	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

Our initial calculations for the anchor bolts connecting the roof trusses to the walls show that the bolts may be inadequate for out-of-plane loads from the concrete walls. In addition, the anchorage of the roof tiles and the tall book shelves should be investigated further. We recommend a rating of V (Poor). We recommend further study to determine the severity of the potential deficiencies.

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 static analysis may be appropriate. Applicable retrofit measures may include providing straps or additional anchor bolts to attach the tops of the walls to the roof diaphragm, providing additional

[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.

anchorage of the roof tile and bookcases, and possibly fiber wrapping or other retrofitting of beams over window openings.

Additional building data	Entry	Notes
Latitude	36.996315	
Longitude	-122.05478	
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	1	
Building occupiable area (OGSF)	3987	
Risk Category per 2016 CBC Table 1604.5	II	Educational occupancy (above 12th grade)
Estimated fundamental period	0.15 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Building height, h_n	14 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Defined using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Defined 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	1.29	
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

[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.

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: 1961 UBC	Code per construction drawings General Notes
Applicable code for partial retrofit	None	No known retrofit
Applicable code for full retrofit	None	-
FEMA P-154 data		
Model building type North-South	C2a - Conc. wall (Flexible Diaphragm)	
Model building type East-West	C2a - Conc. wall (Flexible Diaphragm)	
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

Figure: Annotated floor plan

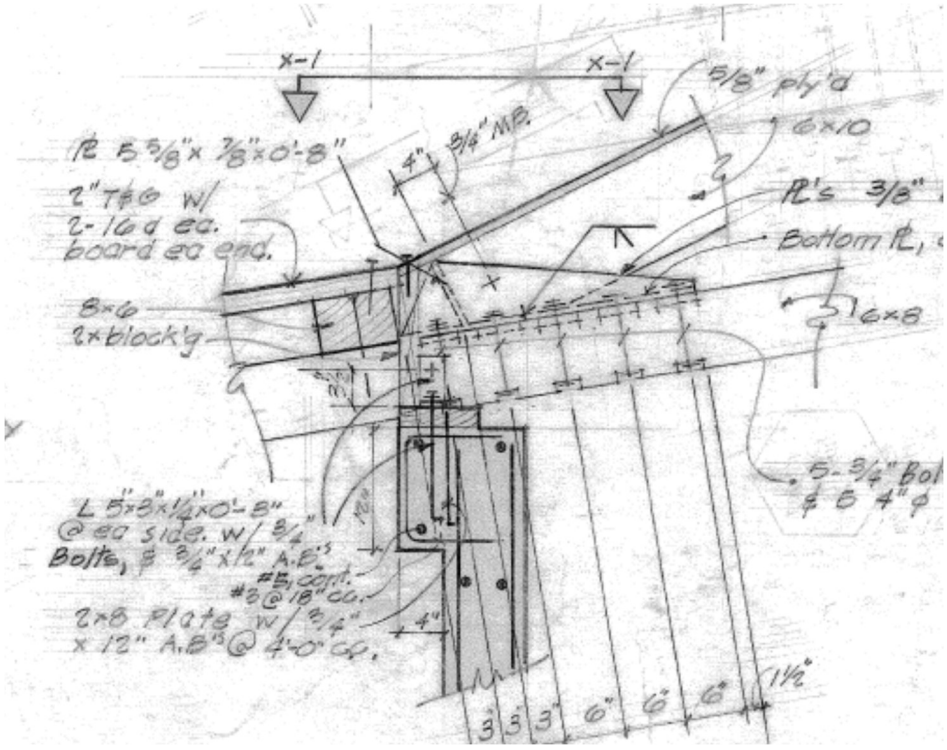


Figure: Detail of roof to wall connection

UC Campus:	University of California Santa Cruz			Date:	12/26/2018		
Building CAAN:	7131	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Cowell Library			Initials:	*NY*	Checked:	*JRM*
Building Address:	523 Cowell Service Road, Santa Cruz CA 95064			Page:	1	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

C NC N/A U	Description
○ ○ ○ ○	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**
○ ○ ○ ○	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
○ ○ ○ ○	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

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C NC N/A U	Description
○ ○ ○ ○	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: 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: C**
○ ○ ○ ○	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**

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Building Address:	523 Cowell Service Road, Santa Cruz CA 95064			Page:	2	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4) **Comments: C**
○	○	○	○	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: C**
○	○	○	○	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: C**

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: C**
○	○	○	○	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**

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Building Address:	523 Cowell Service Road, Santa Cruz CA 95064			Page:	3	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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: C –** least horizontal dimension occurs at perimeter north-south wall, L=42' and h= 19.25'. L/h = 2.18 > 0.6Sa = 0.6*1.55 = 0.93.
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: C –** footings are embedded 18" minimum in soil Site Class C.

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Building Address:	523 Cowell Service Road, Santa Cruz, CA 95064			Page:	1	of	3

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

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C NC N/A U	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1) **Comments: NC –** A complete vertical-load-carrying system independent of the walls is not provided; the exterior walls serve as both bearing walls and shear walls. Preliminary calculations show that the wall piers will remain essentially elastic, but coupling beams at the top of the wall openings may yield in flexure. Calculations show that these beams have adequate capacity to span over the window openings and carry the roof truss weight.
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 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 f'_c. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1) **Comments: C** Avg. v,north-south walls = 21psi < 100 psi, OK Avg. v,east-west walls = 43 psi < 100 psi, OK
C NC N/A U	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3) **Comments: C** $Á_{,vert}$ = $Á_{,horiz}$ = #4 EF @ 18” in 8” wall = 0.0028

Connections

	Description
C NC N/A U	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments: NC** – Steel anchors anchor the walls to the roof trusses in the north-south direction, and to the 6x beams in the east-west direction, at spacing of 8.5’ o.c. These are bolted to the wall with ¾” diameter anchor bolts (2 per truss), which do not appear to have strength for specified connection force. Also, at end bays, it is not clear whether these bolts are provided (see detail 16/S15).
C NC N/A U	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2) **Comments: C**

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Building Address:	523 Cowell Service Road, Santa Cruz, CA 95064			Page:	2	of	3

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: C**

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

Seismic-Force-Resisting System

	Description
C NC N/A U ○ ○ ○ ○	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2) **Comments: N/A –** no secondary elements for gravity load.
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. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3) **Comments: N/A –** no concrete slab
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. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1) **Comments: NC –** upper “coupling beam” is only 12”x12” beam at top of wall, lightly reinforced. Lower “coupling beam” is section of wall below openings, also lightly reinforced.

Diaphragms (Stiff Or Flexible)

	Description
C NC N/A U ○ ○ ○ ○	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments: C**
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. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments: C –** no diaphragm openings

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Building Address:	523 Cowell Service Road, Santa Cruz, CA 95064			Page:	3	of	3

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

Flexible Diaphragms

C	NC	N/A	U	Description
○	○	○	○	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments: NC –** at roof hips, no straps are provided for continuous cross ties
○	○	○	○	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: C**
○	○	○	○	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**
○	○	○	○	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: C –** blocking is provided and diaphragm is plywood sheathing.
○	○	○	○	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: C**

Connections

C	NC	N/A	U	Description
○	○	○	○	UPLIFT AT PILE CAPS: Pile caps have top reinforcement, and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5) **Comments: N/A – no pile caps**

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MAFFEI STRUCTURAL ENGINEERING

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Project:_____
Subject:_____
By:_____
Date:_____

SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General

			Reference
Building	Cowell Library (CAAN 7131)		
Architect	Wurster, Bernardi, and Emmonds Architects		(UCSC database)
Structural Engineer	Gilbert, Forsberg, Diekmann, Schmidt		(UCSC database)
Location	523 Cowell Service Road, Santa Cruz, CA 95064		(UCSC database)
Design date	1964		(Construction dwgs dated 7/26/68)
Latitude	36.996315		(Google Earth)
Longitude	-122.05478		"
Stories above grade	1		

Seismic parameters

*MSE rule for establishing occupant load for risk category as follows. Assume 50 net sf/person per 2016 CBC table 1004.1.2 for "Library" function. Therefore, 3987 sf/50 = 80. Assume 80 occupants, less than 5000.

Risk Category	II*	2016 CBC Table 1604A.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/77d380d355934b38a4489	(ASCE 41-17 3.3.4)
Landslide hazard	Low	http://data-sccgis.opendata.arcgis.com/datasets/7984aabd55ec4a4794ae33d7919bd9c7_133	
S_{DS}	1.312	https://hazards.atcour 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	C2a: Concrete shear walls with flexible diaphragms	(ASCE 41-17 Table 3-1)

Material properties

				Notes	
Concrete	f'_c	3	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 C2a	(ASCE 41-17 Table 4-6)
	~~17.19 Nonstructural Checklist~~ (not performed)	(ASCE 41-17 Table 4-6)

Seismic forces

V	897	kip	$V = Cs_a W$	= 1.80W	(ASCE 41-17 Eq 4-1)
W	498	kip	building weight		(ASCE 41-17 4.4.2.1)
C	1.4		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	0.18	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	19.3	ft	building height		(ASCE 41-17 Eq 4-4)

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

Story	w kip	story ht ft	h ft	wh^k	F_{story}	F_{story} kip	V_{story} kip
Roof	238.0		19	4582	0.90	805	
1	260.0	17.3	2	520	0.10	91	805
Found.		2.0	0	0	0.00	0	897
Total	498	19		5102	1	897	

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	$A_{w\,N\text{-}S}$ in^2	$A_{w\,E\text{-}W}$ in^2	v_{NS}^{avg} psi	v_{EW}^{avg} psi	D/C_{NS}	D/C_{EW}
Roof						
1	10449	4992	17	36	0.2	0.4
Found.	14592	8064	14	25	0.1	0.2
Total						

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

v_{limit} 100 psi $v_{limit} = 2\sqrt{f_c'} \ge 100$ psi

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

Source: University of California, Santa Cruz

COWELL LIBRARY

Seismic load table

ROOF

Tile roof	12 psf
5/8" plywood	2
2×6 rafters @ 24	1.5
trusses @ 7'-6"	5.0
insulation, MEP	5.0
1/2" gyp ceiling	2
	27.5, say 28 psf

FLOOR

1 5/8" conc topping	20
5/8" Plywood	2
2×10 joists @ 16"	3.5
6×10 beams	.7
insulation	2
	28.2, say 29 psf

Partitions - say none

WALL

Perimeter wall	100 psf
8" conc	2.5
5/8" gyp	102.5 psf

Weight of building

$$W_R = (28^{psf}\ roof)(42' \times 76') + (102.5^{psf}\ wall)(2\times41 + 2\times76)(12'\ height)\left(\tfrac{1}{2}\right)$$

(2344)

$$= 89496\# + 143910 = \underline{233^k}$$

$$W_{flr} = (29^{psf}\ floor)(42' \times 76') + (102.5^{psf}\ wall)(2\times41 + 2\times76)\left(\tfrac{12'}{2} + 1\right)$$

$$= 92568 + 167895 = \underline{260^k}$$

Height of build'g = say 2' grade to level 1 + 12' to roof eave + $\frac{21'}{2}$ roof height

$$= 2 + 12 + 5.25 = 19.25'$$

COWELL LIBRARY (cont)

WALL SUMMARY

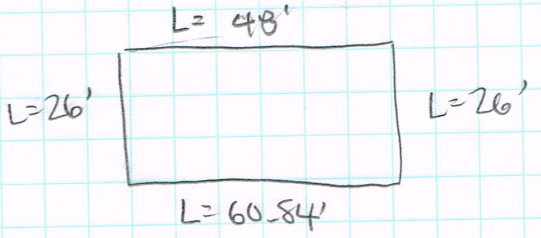
R- 1ST	$76' - 2(6) - 2(8) = 48'$	(north)
	$76' - 2(2.58) - 8(1.25) = 60.84'$	(south)
	$42' - 2(8) = 26'$	(east)
	$42' - 2(8') = 26'$	(west)

$\Sigma_{N-S} = 108.84' \times 12 \times 8'' = 10449 in^2$

$\Sigma_{E-W} = 52' \times 12 \times 8'' = 4992 in^2$

1ST - found	$76' \times 12 \times 8'' \times 2 = 14592 in^2$	(north) (south)
	$42' \times 12 \times 8'' \times 2 = 8064 in^2$	(east) (west)

CORigidity



$\bar{y}_{COR} = \frac{48(0) + 60.84(26)}{(48 + 60.84)}$

$= 14.5'$

$\bar{y}_{COM} = 13'$

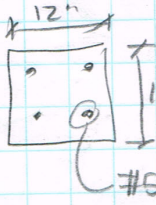
$(y_{COR} - y_{COM}) = 1.5' < 26(.20) = 5.2'$ ✓OK

Out-of-plane flex diaphragm connectl

- $T_c = \phi S_{XS} W_p A_p = 1.0(1.546)(102^{psf}_{wall} \times 6' \text{ height}) = 946^{\#}/ft$

  Say top beam spans 76' ⇒ $M_U = \frac{wL^2}{8} = \frac{(.946 \times 76')^2}{8} = 688 kft$

  $V_U = \frac{wL}{2} = \frac{(.946)(76)}{2} = 36^k$



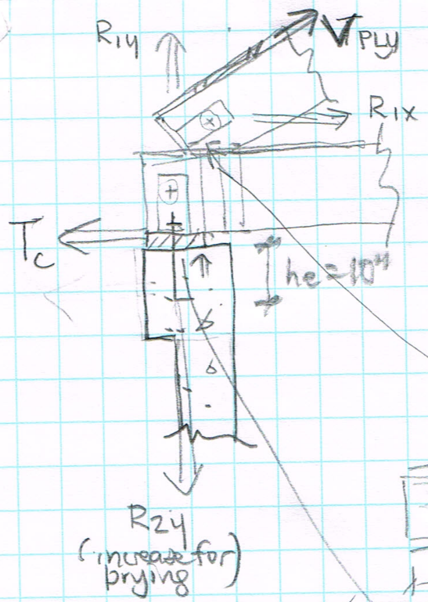
$\phi M_n = .9(.62 \times 40)\left(\frac{12''}{12}\right) = 21^{kft}$ NG

OK to span 15' max 8'-6" ✓OK

- Check to support truss midspan,

$P = 21'(8.5')(1.2 \times 28 + 0.5 \times 20) = 7.8^k$

$M = \frac{PL}{4} = \frac{7.8(8)}{4} = 15.6 kft \Rightarrow A_s = \frac{15.6 \times 12}{.9 \times 40 \times 10} = .52 in^2$



For max spacing of 8'-6", $T_c = 946(8.5') = 8041\#$

$R_x = 8041\#$

$R_y = \frac{R_x}{2} = 4020\#$; $V_{PLY} = 8990\#$ (v)

$R_{2y} = 4020\#\left(\frac{15''}{5''}\right) = 12060\#$

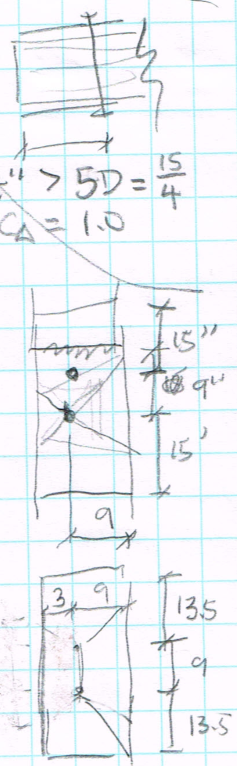
Check 3/4"Ø bolt in 6x member w/ 1/4" side plates – $R_n = 7736\# < 8990\#$

$Z = 3320 \times \cancel{3.0} \times 3.32 \times 1.0 \times \lambda$ (LRFD × φ; λ = 1.0)

$= 11022\# > 8990\#$ ✓OK

✓ 4" > 5D = 15/4

$C_\Delta = 1.0$



Check 2-3/4"Ø × 12" AB

$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \psi_{ec} \psi_{ed} \psi_c \psi_{cp} = \frac{12(39)}{9(10)^2}\left(24 \times 1 \times \sqrt{3000} \times 10^{1.5}\right)$

(1, 0.76, 1, 1)

$= \frac{468}{900}(.76)(21.6\#) = 8542\#$

$V_{cb} = \frac{A_{Vc}}{A_{Vco}} \psi_{ed} \psi_c \psi_h V_b = \frac{36(13.5)}{4.5(9)^2}\left(9\sqrt{3000} \times 9^{1.5}\right)$

$= \frac{121.5}{40.5}(1.0)(256\#) = 17746\#$

$\left(\frac{12060}{17746}\right) + \left(\frac{4020}{8542}\right) = 1.82 > 1.2$ NG

× .8 open'g

1.5